

Effect of Short Photoperiod on Some Growth Traits in Sprague Dawley Rats ^[1]

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Summary

The effect of short photoperiod on some growth traits in outbred Sprague Dawley rats was examined. The pups were assigned to two photoperiod groups: long/routin (12 h light/dark: control) and short (9 h light/15 h dark: experiment) lighting, since, in nature, photoperiod may decrease to 9 hours in winters, in subtropical regions. At 15 weeks of ages, body weight, weight of heart, liver, spleen, lungs, kidneys, gastear, adrenal glands, testis and ovaries of the rats from experimental group were compared to those in control group. Body growth, weight of heart, liver and spleen and large intestine length in control and experimental rats were not significantly different ($P>0.05$). No differences were observed in testis and ovary weights between control and experiment groups, statistically. Rats exposed to short photoperiod had lower lung, kidney, gastear, adrenal gland and intestine weight than those of control rats ($P<0.01$ and $P<0.05$). In outbred Sprague Dawley rats, short photoperiod had no effect on body growth and reproduction organs and it is concluded that, there may be a chance for some strains of outbred Sprague Dawley rats to be kept under short photoperiod conditions, without reducing body weight and reproductive organ growth.

Keywords: *Sprague dawley, Photoperiod, Growth*

Sprague Dawley Ratlarda Kısaltılmış Işık Süresinin Bazı Büyüme Özelliklerine Etkisi

Özet

Outbred Sprague Dawley ratlarda, kısaltılmış ışık süresinin bazı büyüme özelliklerine etkisi incelendi. Yavrular 12 sa aydınlık/karanlık (kontrol) ve doğal şartlarda, kış mevsiminde, subtropik bölgelerde gerçekleşen kısa ışık süresi kadar (9 sa aydınlık/15 sa karanlık: muamele) olmak üzere iki fotoperyot şartına maruz bırakıldılar. Muamele grubu ratlarda, 15 haftalık yaşta, canlı ağırlık, kalp, karaciğer, dalak, akciğer, böbrek, mide, adren, testis, ovaryum, kalın ve ince bağırsakların ölçümleri, kontrol grubu ile karşılaştırıldı. Vücut ağırlığı artışı ile kalp, karaciğer, dalak ağırlık ve kalın bağırsak uzunlukları, kontrol ve muamele grupları arasında farklılık göstermedi ($P>0.05$). Kontrol ve muamele grupları arasında testis ve ovaryum ağırlıkları arasında da istatistiksel olarak bir farklılık gözlenmedi. Kısa fotoperyota maruz bırakılan ratların akciğer, böbrek, mide, adren ve ince bağırsakları, kontrol grubuna göre daha düşük ağırlıklarda belirlendi ($P<0.01$ ve $P<0.05$). Kısa fotoperyodun, outbred Sprague Dawley ratlarda, vücut ve üreme organlarının ağırlığı üzerinde etkisi bulunmadı ve bazı outbred Sprague Dawley rat soylarının, vücut ve üreme organlarında ağırlık kaybı olmaksızın kısa fotoperyot şartlarında da yetiştirilebilme şansı olabildiği sonucuna varıldı.

Anahtar sözcükler: *Sprague Dawley, Fotoperyot, Büyüme*

INTRODUCTION

Laboratory rats are bred in micro environments, where physiological needs are optimally supplied. Photoperiod is one of the biological needs of rats, and in common, 12 h light: 12 h dark lighting regime is used. However, in natural conditions, it is known that, even the light period is less than 9 h, rats continue their biological activities, including reproduction ^[1].

Photoperiod regulates melatonin level, epiphysis gland and organ development ^[2] and the respond varies according to breed, family and strain of the rats ^[3]. In Fischer (*F344*) rats, which are exposed to short photoperiod, puberta longened, feed intake and cellular growth decreased ^[4]. Feed intake did not differ in Zucker rats in both short and long photoperiod ^[5].



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It is reported that, youngers are more sensitive to photoperiod than olders, in most rodent species^[6]. Pups, exposed to short lighting (6 h, daily) had less growth rate but similar feed intake, when compared to those, subjected to long (12 h) photoperiod^[7].

In F344 rats that exposed to short lighting after birth, had similar feed intake and body growth but less testis volume than the animals, kept in 12 h lighting conditions^[8].

In scientific literature, very limited number of researchs, related to organ development of rodents, which were subjected to various lighting environments, is available. Short photoperiod did not effect spleen weight but inhibited testis and uterus growth in the Marsh rats^[9] and short lighting regime also had a suppressive effect on adrenal growth in Wistar rats^[10]. In Mongolian gerbil, uterus, testis and body weight, as well as, feed intake were significantly affected by various environmental factors, including lighting^[11]. In the male deer mice (*Peromyscus maniculatus*), short photoperiod significantly inhibited reproduction organ growth^[12]. Reproduction organs of *Prairie voles* males were negatively affected by short lighting period, and females had lower uterus and ovarium weights when compared to those, kept in long photoperiod condition^[13].

In mice, it is noticed that gonads were reduced in weight, when exposed to short lighting^[14], but according to another research, body and testis weight were not affected by lighting methods^[15]. Short photoperiod (8 h) resulted in a decrease of testis measures, feed intake, body weight, puberta period in F344 rats^[8].

To the best of the authors knowledge, there is scarce knowledge in scientific literature, on the the relation between photoperiod and growth in Sprague dawley rats, one of the common used rat breed.

Energy sources of the World are not enough to meet the demands of the humanity. Energy saving methods have been in the news of both developed and developing countries, in recent years. For scientific aims, billions of rodents are still kept in artificial lighted environments, by using a serious amount of electrical energy.

The aim of present study was to compare the effect of short (9 h) and long/routin photoperiod (12 h) lighting on the growth traits of Sprague dawley pups from birth to the weeks that they reached to 200 g body weight and examine the possibility of keeping Sprague dawley rats during shortened photoperiod, just as in 'natural' conditions, in winters of subtropical regions and so the possibility of energy saving.

MATERIAL and METHODS

The trial protocol was approved by the ethics committee of Ataturk University, Turkey, (number: ATA-28.11.2008 /84).

Twenty out bred Sprague dawley females, 6 months of ages, in the second partrition, specific patogen free, at similar weights were divided into 2 groups. Mean weight of females were 224.1±14.6 gr for control (long/routin photoperiod: 12 h light: 12 h dark) group, 232±12.6 gr for experiment (short photoperiod: 9 h light: 15 h dark) and the females were mated and kept in individual cages (47x35x20 cm), 21±2°C and 55±5% relative humidity room conditions. White color lighting was supplied, the light intensity was 150 lux, and equally distibuted on the cage floor^[1].

Pups were weighed after birth, 7th, 14th and 21st of birth day, and after preweaned on 21st day, the pups were seperated according to sex and transferred to the cages. The cages were 50x30x30 cm, 10 pups/cage. Feed consumption were recorded, weekly. At the end of 15th week, 10 females-10 males were randomly chosen from control and experiment cages and were starved for 12 h, anaesthetised and the abdomens were incised, *Aorta abdominalis* was cut and bled. The ventricles of heart were palpated the residual blood was removed and the heart was weighed. The spleen, liver, kidney, ovary, testis, adrenal gland, gastear and lung were removed and weighted (CAS, Model: ME-410). Content of the large and small intestines were removed, intestines were weighed and length of the intestines were measured by a ruler. The statistical methods were:

Model was used to analyse of birth-preweaned period, 0-3 weeks

Model was used for 4-15. weeks

Model was for organs, ovary-testis analyse

I. Model $y_{ij} = \mu + C + b_i + e_{ij}$

II. Model $y_{ijk} = \mu + b_i + s_j + (bs)_{ij} + e_{ijk}$

III. Model $y_{ij} = \mu + b_i + e_{ij}$

C: Kovariance (numbers of pups),

b_i: Effect of experiment (photoperiod),

s_j: Effect of sex,

(bs)_{ij}: Interaction (experiment and sex),

SPSS 9.0 statistical programme, General Linear Model (GLM) procedure was performed.

RESULTS

Mean weight values and variance analyse results for birth-preweaning period are presented in *Table 1*. Short photoperiod had not significant effect on body weight in pups, until preweaning at the end of 3. weeks of ages (P>0.05).

Control group (37 rats) consumed 52.32 kg; experiment group (39 rats) 53.12 kg, after preweaned period (4-15. weeks). Body weight were similar in both groups between 4. and 9. weeks (P>0.05), (*Table 2a*). Body weight of the male and female rats was significantly different between 10-15

weeks ($P < 0.01$), (Table 2b).

At the end of trial, at 15th week, both groups were statistically similar in weight ($P > 0.05$), (Table 3). The weight of spleen, heart, liver and length of large intestine were also similar in control and experiment groups ($P > 0.05$), (Table 3).

The mean weight of gastrea, kidneys, adrenal glands, intestines and length of small intestines of long photoperiod group were significantly higher than those of exposed to short photoperiod ($P < 0.05$ and $P < 0.01$), (Table 3). At the end of trial, at 15th week, both groups were statistically equal in testis and ovary weight ($P > 0.05$), (Table 4).

Table 1. Mean and standard error ($X \pm Sx$) and variance analyse results of body weight between birth-preweaned [0-3 weeks] periods of pups

Tablo 1. Doğum-sütten kesim arası [0-3 hafta] yavruların canlı ağırlık ortalamaları ve standart hataları ($X \pm Sx$) ile varyans analiz sonuçları

Weeks	Group	N	$X \pm Sx$	P
1	Control	78	6.18±0.43	NS
	Experiment	61	7.33±0.43	
2	Control	55	13.86±1.01	NS
	Experiment	51	14.56±0.93	
3	Control	41	26.52±2.01	NS
	Experiment	50	23.68±1.87	

NS: Non-significant

DISCUSSION

Short photoperiod inhibited growth in hamsters [16,17] but stimulated in *Prairie voles* [13]. In wistar pups, exposed to 6 h lighting, body weight was lower than those of controls [7]. Six hours lighting is not natural for the World's photoperiod system and it may not be appropriate for the growth of the wistars.

F344 rats did not reduced body weight and feed intake when exposed to short lighting [8]. Similar result is obtained in the present research and the body weight of Sprague dawley rats, until 15th week and the growth was not affected by the 9 h lighting regime. Some rodent strains were recorded not to be very sensitive to photoperiod [18], however, some researchers declared that the photoperiod had a significant effect on growth of the laboratory rodents [19].

F344 and Brown Norway rats reacted to 8 h lighting by reducing feed intake and body weight, where as body weight of Harlan Sprague dawleys decreased about 5-10% [3]. It is recorded that, if F344 rats, which were exposed to short photoperiod after a long photoperiod term, their growth traits were negatively effected, but if they were exposed to short lighting regime just after birth, the lighting time had no negative effect on the growth traits [19].

In present study, growth traits of Sprague Dawley rats were not affected by experiment but sex ($P < 0.05$ ve

Table 2a. Mean and standard error ($X \pm Sx$) and variance analyse results of body weight after preweaned [4-9 weeks] period of rats

Tablo 2a. Sütten kesim sonrası [4-9. hafta] ratların canlı ağırlık ortalamaları ve standart hataları ($X \pm Sx$) ile varyans analiz sonuçları

Groups	Sex	4. Weeks	5. Weeks	6. Weeks	7. Weeks	8. Weeks	9. Weeks
Control	M	44.19±1.4	64.00±5.0	95.53±6.8	136.97±8.1	161.83±10.6	179.88±11.0
	F	41.52±1.4	57.95±5.0	84.97±6.8	108.76±8.1	119.23±10.6	130.60±11.0
Experiment	M	41.73±1.7	59.93±6.1	87.05±8.3	118.08±9.9	136.63±12.9	150.51±13.4
	F	40.24±1.6	62.86±5.5	87.55±7.4	111.77±8.8	131.17±11.6	140.82±12.0
Sex		NS	NS	NS	NS	NS	*
Experiment		NS	NS	NS	NS	NS	NS
Sex x Experiment		NS	NS	NS	NS	NS	NS

NS: Non-significant, * $P < 0.05$

Table 2b. Mean and standard error ($X \pm Sx$) and variance analyse results of body weight after preweaned [10-15 weeks] periods of rats

Tablo 2b. Sütten kesim sonrası [10-15. hafta] ratların canlı ağırlık ortalamaları ve standart hataları ($X \pm Sx$) ile varyans analiz sonuçları

Experiment Groups	Sex	10. Weeks	11. Weeks	12. Weeks	13. Weeks	14. Weeks	15. Weeks
Control	F	190.53±13.3	211.92±11.2	230.29±12.7	241.39±13.2	256.86±15.4	278.06±16.1
	M	157.50±11.9	160.30±10.0	169.70±11.3	175.11±11.8	180.59±13.7	184.07±14.4
Experiment	F	190.53±13.3	211.92±11.2	230.29±12.7	241.39±13.2	256.86±15.4	278.06±16.1
	M	157.50±11.9	160.30±10.0	169.70±11.3	175.11±11.8	180.59±13.7	184.07±14.4
Sex		**	**	**	**	**	**
Experiment		NS	NS	NS	NS	NS	NS
Sex x Experiment		NS	NS	NS	NS	NS	NS

NS: Non-significant, * $P < 0.05$

Table 3. Mean and standard error ($X \pm Sx$) and variance analyse results of body weight and organ weight**Tablo 3.** Canlı ağırlık, organ ağırlık ortalamaları ve standart hataları ($X \pm Sx$) ile varyans analiz sonuçları

Traits	Control	Experiment	P
Body weight (g)	223.84±2.84	215.90±2.84	NS
Spleen (g)	0.50±0.02	0.44±0.02	NS
Heart (g)	0.87±0.04	0.78±0.04	NS
Liver (g)	7.21±0.25	7.79±0.25	NS
Kidneys (g)	2.07±0.05	1.90±0.05	*
Adrenal glands (g)	0.13±0.01	0.09±0.01	**
Gastear (g)	1.74±0.08	1.49±0.08	*
Large intestine (cm)	15.40±0.47	13.95±0.47	NS
Small intestine (cm)	99.00±1.50	91.05±1.50	**
Intestine total (g)	14.18±0.43	13.17±0.43	**
Lungs (g)	1.78±0.08	1.44±0.08	**

NS: Non-significant, * $P < 0.05$, ** $P < 0.01$

Table 4. Mean and standard error ($X \pm Sx$) and variance analyse results of ovary and testis weight**Tablo 4.** Ovaryum ve testis ağırlık ortalamaları, standart hataları ($X \pm Sx$) ile varyans analiz sonuçları

Reproductive Organ	Group	N	$X \pm Sx$	P
Ovary (g)	Control	10	0.10±0.01	NS
	Experiment	10	0.25±0.08	
Testis (g)	Control	10	2.57±0.09	NS
	Experiment	10	2.47±0.09	

NS: Non-significant

$P < 0.01$). Males had significantly higher weight than females and the result was previously confirmed by Poyraz [1].

In the marsh rice rat (*Oryzomys palustris*) and Siberian hamsters, short photoperiod was reported to be ineffective on spleen growth [20]. In the present study, spleen, heart and liver weight of rats, also length of large intestines were not affected by 9 h lighting regime. Rats, subjected to 12 h light: 12 h dark photoperiod, had higher adrenal glands than those exposed to 9 h lighting, the present results were in accordance with those reported for Wistar rats [10]. Adrenal glands were noticed to be most sensitive tissue to the photoperiod in Sprague dawley and Wistar rats [10].

In scientific literature the researches, examining the relation between photoperiod and organ weight are very limited. It is thought that, the results may be present the reference values, for better understanding the photoperiodic response of Sprague dawley out bred rats.

Testis and ovary weight of rats were not affected significantly by short photoperiod lighting ($P > 0.05$), (Table 4), including pubertal period. It is reported that, 12, 14 and 16 h lighting were not effected the ovary weights of *Oryzomys palustris* [20].

In mice, it is declared that testis weight was not effected by short photoperiod [15] but another research determined a reduction in gonads of females [14]. In marsh rice rats, testis, ovary and uterus growth were significantly and negatively affected by short photoperiod [9]. Similar results were declared for also deer mice (*Peromyscus maniculatus*) and some hamster strains [12,21].

Reproductive organ growth were inhibited by short photoperiod in *Prairie voles* males, but fertilization was not impressed both in males and females [13]. Before puberta, F344 rats, subjected to short (8 h) had similar reproduction organ weight when compared to the ones, kept in long photoperiod regime (16 h) [8]. Presents results stated that, weights of testis and ovary in Sprague Dawley rats were not impressed by 9 h photoperiod, however, some of the strains of Harlan Sprague dawleys, like ACI, BUF and PVG males had lower (5-20%) testis weight than those kept in long photoperiod lighting [3].

When compared to previous results, it is noticed that reaction of the rodents to photoperiod may significantly differ, according to the species, breed, strain, family of the animals. It is concluded that, there may be a possibility for reducing routine the artificial lighting (12 L: 12 D) up to 25% in rat breeding systems, without a decrease in body, testis and ovary weight. If supported by advance researches, lighting periods may be reduced/adapted to the flocks, species, strains of the animals, so that there will be a chance to save the electrical energy of the World.

It is also thought that, breeding/keeping procedures of the laboratory animals should be re-arranged according to the breed, strains and family of the animals and lighting needs of rodents should be discussed for each species.

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