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EFFECT OF DIFFERENT SHED TYPES, AS ALLEVIATION MEAN OF HEAT STRESS, ON BODY REACTIONS AND GROWTH PERFORMANCE OF CROSSBRED CALVES.

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ABSTRACT

A total of 100 healthy male Friesian-Baladi crossbred calves at 9-10 months of age and averaged 218 kg live body weight belonging to a private farm were selected and divided into four equal groups. Each group was kept separately in corral with earthen floor under loose semi-shaded system in the summer season (from June to September). The first group's corral was roofed with shade-net (treated polyethylene shade-cloth), the second group's corral was roofed with reed mat, and the third group was kept under asbestos shade and provided with a nutritional additive consists of mineral mixture and urea (NPN). The three different groups were used to compare them with a control group (G1) which was kept in a corral roofed with asbestos only. Feed and water consumption were recorded to estimate dry matter intake (DMI) and water intake (WI). Temperature Humidity Index (THI) was calculated according to maximum-minimum temperatures and humidity, which were recorded daily. In addition, the upper, lower shade surface and the ground under the shade temperature of different shade materials were recorded. Skin temperature (ST) and respiration rate (RR) were recorded three times per day, also, daily weight gain (DWG) was calculated. Results showed highly significant differences ($P< 0.01$) among the different treatments on DWG, FI, WI, ST and RR. There were highly significant correlations between animal responses and the environmental conditions. it could be concluded that keeping animals under shade-net or reed shades with well-ventilated area give better growth performance than keeping animals under asbestos shade even with nutritional additives and NPN.

Key words: shade-net, reed, asbestos, diurnal and monthly variations, male calves, body reaction, daily weight gain.

INTRODUCTION

Heat stress occurs when any combination of environmental conditions causes the effective temperature of the environment to be higher than the animals' thermoneutral zone or comfort zone (Collier *et al.*, 1981). West (1993) reported that heat stress resulted when animals are exposed to hot or to hot and humid environmental conditions. Thermal stress during the summer can negatively impact animal performance. West *et al.* (2003) indicated that DMI was most sensitive to the air temperature. They indicated that, DMI declined 0.85 kg for each degree (°C) increase in the air temperature. In addition, the environmental hot conditions caused a reduction in growth rate, that represent sizable economic losses to producers of intensively managed livestock (Beede and Collier, 1986), reduced feed intake, increased water intake, changed metabolic rate and maintenance requirements, increased evaporated water loss, increased respiration rate (RR), skin temperature (ST), and increased body temperature (Nasser, 1992, Armstrong, 1994 and Ronchi *et al.*, 2002). The most important environmental stresses today are those that have resulted from housing and other attempts to ameliorate the effect of hot or cold stress (Webster, 1983). Beede and Collier (1986) identified three management strategies to minimize the effects of heat stress: 1) physical modification of the environment (shading, cooling), 2) genetic development of heat-tolerant breeds, and 3) improved nutritional management practices. Buffington *et al.* (1983) defined shades as thermal radiation shields, change the radiation balance of an animal but do not affect air temperature or humidity. In the subtropical countries like Egypt, Kotby, *et al.* (1987) stated that the proper shading during hot weather is a great significance, since farm animals suffer from high environmental temperatures for about eight months of a year from March to October. Sheds have good impact on animal performance, which improved gain performance of feedlot cattle (Mitlohner *et al.*, 2002), decreased respiration rate to 38 % compared with unshaded animals (Fawzy-Soheir *et al.*, 1998, Mitlohner *et al.*, 2002 and El-Diahy, 2004). Moreover, type of sheds have different effects on animal performance, the body weight gain of buffalo calves kept under giant reed shed, it had satisfied body weight gain and consumed little water, while body weight gain decreased sharply under asbestos shed (Mohamed, 1993 and El-Sobhy *et al.*, 1993). However, Ashour *et al.* (1998) found that Friesian calves had better comfort conditions under asbestos roofed for body reactions compared with those kept under concrete roofed. The objective of this study was to evaluate the effects of different shed types roofs on body reactions (RR and ST) and growth performance of crossbred calves, as means of thermal stress alleviation.

MATERIALS AND METHODS

Experimental Animals and Housing Management:

A total of 100 healthy male Friesian-Baladi crossbred calves at 9-10 months of age and averaged 218 kg live body weight belonging to a private farm in Giza Governorate, were selected and divided into four equal groups according to their weights to be used in this study. Each group was kept separately in corral with earthen floor under loose semi-shaded system in the summer season (from June to September, M_1 to M_4).

In this study, three shade constructions were used for three animal groups (G2, G3 and G4). The first group was kept in corral roofed with shade-net (treated polyethylene shade-cloth), the second group was kept in corral roofed with reed mat, and the third group was kept in corral roofed with asbestos and provided with a nutritional additive consists of mineral mixture and urea (NPN). The three different groups were used to compare them with a control group (G1) which was kept in corral roofed with asbestos only. Moreover, the corral of second and the third groups had shad frames containing steal metal wires instead of metal pipes as in the ordinary frames (G1 and G4). The shaded area ($100m^2$) covered 45% of the total space of the yard ground. Daily maximum and minimum ambient temperatures (°c), relative humidity (%) and air velocity (m/s) were recorded by digital instruments during the experimental period to calculate the temperature humidity index (THI) (Table 1) as an indicator of adverse climatic conditions (AETG, 1980).

THI= db - [(0.55 - 0.55 RH) (db - 58)] .

Whereas: db = dry bulb temperature (°F).and RH= relative humidity% /100.

In addition, the daily ground temperatures under the shades and its upper and lower surface temperatures were recorded three times per day at 7.0 am, 2.0 pm and at 7.0 pm. using digital infrared thermometer and tabulated as an average of the three values (Table 2). Daily ration offered, ad-libtum, at 7.0 am. Daily feedstuffs offered separately on the same feed troughs, it was composed of corn silage with ears, rice straw, and concentrates feed mixture in the summer months from June to September. Concentrates feed mixture (CFM) composed of (50% corn, 20% extracted cotton seed meal, 11% linseed meal, 5% soybean meal, 10% beet balbe, 3% limestone, 0.8% salt and 0.2% mach minerals).

Experimental Measurements:

Daily weight gains (DWG), dry matter intake (DMI), water intake (WI), thermo-respiratory responses (RR and ST) were studied during the experimental periods for the four groups. The daily weight gain (DWG) was calculated monthly, according to the following equation: DWG = (LBW_2 - LBW_1) / D Where LBW_1 is the initial body weight (kg.), LBW_2 is the final body weight (kg.) and D is the days weight interval. The FI calculated as DMI (kg/d), and WI (L/d) was calculated by dividing the difference between a constant measured water level in the trough and the residual water level after 24 h by the number of animals in each group. Skin temperature (ST) and respiration rate (RR) were recorded three times a day at 7.0 am, 2.0 pm and 7.0 pm. The ST (°c) was measured by a digital infrared thermometer and the RR (r.p.m.) was measured by counting the movement of the flank through for one minute using a stopwatch. These observations were recorded for three times per week.

Statistical analyses:

Statistical analyses of data were carried out applying the package of SAS (1996) according to the following models:

$Y_j = \mu + X_j + e_j$.

$Y_{ijk} = \mu + X_i + X_j + X_{ij} + e_{ijk}$.

$Y_{ijkl} = \mu + X_i + X_j + X_k + X_{ijk} + e_{ijkl}$.

Where:

Y = observation,

μ = mean

X_i = effect of treatments

X_j = effect of month

X_K = effect of day time

X_{ij} = the interaction of treatments and month

X_{ijk} = the interaction of treatments, month and day time

e_{ijk} and e_{ijkl} = experimental errors

RESULTS AND DISCUSSION

1. Environmental Conditions:

The temperature humidity index (THI), ground temperatures and upper and lower surface temperatures of the different shades during the experimental periods are shown in Tables (1 and 2).

The THI results showed that there were great diurnal differences in the climatic conditions. The highest THI values were found at the time of recording the maximum temperature which is usually in the midday around 2.0 pm. and the lowest THI values were found at the time of recording the minimum temperature which is usually at the dawn around 4.0 am. The results showed also that there were monthly differences in the climatic conditions, where the THI results in July showed the highest values at the two times of recording temperatures compared with the other months.

According to Johnson (1987), the upper critical THI for cattle is 72. Therefore, calves were suffering from heat stress at midday in the summer season. Mader *et al.* (2006) stated that although knowledge of THI alone is beneficial in determining the potential for heat stress, wind speed and solar radiation adjustments to the THI would be more accurately assess animal discomfort. Table (2) showed that the shade-net (Shdnet) had the lowest temperature values (°C) for the ground and the surfaces compared with asbestos and reed shades which reflected positively on the body reactions and growth performance. The highest temperatures of the Asbestos shade reflected negatively on the animal physiological parameters.

Table (1): Averages of temperature humidity index (THI) during the experimental period.

	Temperature humidity index (THI)	
Month	**At Maximum temp.**	**At Minimum temp.**
June	89.8	67.3
July	96.4	68.9
August	95.4	68.5
September	88.0	67.5
Average	**92.4**	**68.1**

Table (2): Means ± SE of ground temperatures, upper surface and lower surface temperatures of the different shades during the experimental periods.

Month	Ground temp. under shade			Upper shade surface temp.			Lower shade surface temp.		
	Asbest.	Shdnet	Reed	Asbest.	Shdnet	Reed	Asbest.	Shdnet	Reed
June.	28.9±.2	25.6±.2	26.6±.2	35.3±.2	31.1±.2	31.9±.2	36.3±.2	28.5±.2	30.1±.2
July	30.2±.2	27.4±.2	28.7±.2	37.6±.2	33.1±.2	35.6±.2	38.7±.2	29.6±.2	31.4±.2
August	29.6±.2	26.9±.2	28.2±.2	36.9±.2	32.4±.2	34.4±.2	37.9±.2	28.3±.2	30.7±.2
September	28.5±.2	25.0±.2	26.4±.2	33.7±.2	29.2±.2	30.9±.2	34.9±.2	26.3±.2	29.2±.2
Average	**29.3±.2**	**26.2±.2**	**27.5±.2**	**35.9±.2**	**31.5±.2**	**33.2±.2**	**37.0±.2**	**28.2±.2**	**30.4±.2**

2. Feed and Water Intakes:

The effects of different shed types on dry matter intake (DMI, kg) and water intake (WI, L) are presented in Tables (3 and 4).

The results showed that there were significant differences (P< 0.01) between the effects of the different types of shades on DMI and WI during the experimental period. The animals of G_2 and G_3 showed higher DMI values (8.36 and 8.39 kg/d/head, respectively) compared with G_1 and G_4 (8.16 and 8.19 kg/ d/head, respectively). This result is in accordance with higher daily gain of calves in these groups (G_3 and G_2) compared to those in G_1 and G_4. Regarding to WI, the result of G_4 showed the highest value of WI (35.01 l/d/ head) compared the other groups. In addition, the results showed also that there were monthly differences between the effects of the different types of shades on DMI and WI during the experimental periods. The results of M4 showed the highest values of DMI and WI compared with the other months. These results may reflect the highest values of ambient temperature under asbestos shades yards, in G1 and G4 in summer than shade-net and reed shades in G3 and G2. Also, indicated that asbestos shade is consider a thermal material, absorbs and keeps heat throughout the day time then radiates it through night. So that, asbestos material changes ambient temperature around it and makes thermal conditions throughout day and night. Whereas, shade-net or reed materials may be allows thermoneutral night environment, which permits animals to consume their feeds during the evening and night. The animals in G2 and G3 consumed more DMI because the reed and shade-net materials provided more comforttable environment compared with asbestos material, while the animals in G_4 consumed more WI because of the nutritional additives. These results are in agreement with those obtained by Ashour (1990) who reported that water intake is affected by several factors such as: increase of dry matter intake, quality of the feed intake, level of Na Cl. and climatic factor affecting water intake. NRC (1981) reported that the increases in respiratory rate and water consumption as will as decreased rumen motility; all contribute towards reducing appetite and intake. It is will established that high environmental temperature stimulates the peripheral thermal receptors to transmit suppressive nerve impulses to the appetite center in the hypothalamus causing decrease in the feed consumption to minimize thermal load. West (2003) stated that increasing air temperature, THI and rising rectal temperature above critical thresholds are related with decreasing dry matter intake (DMI).

Table (3): Means ± SE of dry matter intake (DMI kg/d) during summer months as affected by shade type.

Treatments Months	G_1 Control group	G_2 Reed group	G_3 Shade-net group	G_4 Additives group	Means*
M_1 (Jun.)	6.53±0.11	6.70±0.11	6.68±0.11	6.55±0.11	**6.62±0.05^D**
M_2 (Jul.)	7.83±0.11	7.88±0.11	7.96±0.11	7.80±0.11	**7.87±0.05^C**
M_3 (Aug.)	8.72±0.11	9.01±0.11	8.94±0.11	8.75±0.11	**8.85±0.05^B**
M_4 (Sept.)	9.56±0.11	9.85±0.11	10.0±0.11	9.65±0.11	**9.77±0.05^A**
Means	**8.16±0.05^b**	**8.36±0.05^a**	**8.39±0.05^a**	**8.19±0.05^b**	**8.28±0.05**

* Means within each column and row having different letters are significantly different at p<0.05.

Table (4): Means ± SE of water intake (WI, L/d) during summer months as affected by shade type.

Treatments Months	G1 Control group	G2 Reed group	G3 Shade-net group	G4 Additives group	Means*
M_1 (Jun.)	26.87±0.42	25.07±0.42	24.30±0.42	28.37±0.42	**26.15±0.21^D**
M_2 (Jul.)	33.90±0.42	33.39±0.42	33.32±0.42	34.51±0.42	**33.78±0.21^C**
M_3 (Aug.)	37.58±0.42	37.87±0.42	38.30±0.42	37.99±0.42	**37.94±0.21^B**
M_4 (Sept.)	39.02±0.42	39.23±0.42	3949±0.42	39.15±0.42	**39.22±0.21^A**
Means	**34.34±0.21^b**	**33.89±0.21^b**	**33.85±0.21^b**	**35.01±0.21^a**	**34.27±0.21**

* Means within each column and row having different letters are significantly different at p<0.05.

3. Daily weight gain:

The results in Table (5) showed that the DWG values were affected by the different shade materials. The animal under shade-net had significantly higher (P<0.01) values of DWG compared with those in the others the three groups under the same environmental conditions of the farm. The shade-net provided more comfortable air temperature than other shades especially the asbestos shade which provided much heat load that reflected negatively on the DMI (Table 3) and decreased the DWG (Table 5). This result is in agreement with Bianca (1965) who reported that the decreasing of the anabolism occurs, particularly, in the metabolizable energy for both maintenance and gain weight and Daader *et al.* (1989) who reported that the total body weight was decreased significantly in hot summer. Sakaguchi and Gaughan (2002) reported that exposing animals to high or low air temperature for a long time results in decreasing the daily weight gain. On the contrary, Muhamed *et al.* (1983) found that steers gained more (P<0.05) in summer than in winter, especially for calves that reared outdoors. The results showed also that there are no significant monthly differences for DWG among the four months in the summer season (Table 5). However, the DWG increased gradually started from June to September. This result is in agreement with Sayah (2005) who found that animals became adapted to its environment after exposing to severe climatic conditions.

Table (5): Means ± SE of daily weight gain (DWG kg./d) during summer months, as affected by shade type.

Treatments Months	G1 Control group	G2 Reed group	G3 Shade-net group	G4 Additives group	Means*
M_1 (Jun.)	0.94±0.04	1.07±0.04	1.14±0.04	0.99±0.04	**1.03±0.02^A**
M_2 (Jul.)	0.95±0.04	1.07±0.04	1.14±0.04	0.99±0.04	**1.04±0.02^A**
M_3 (Aug.)	0.99±0.04	1.10±0.04	1.17±0.04	1.01±0.04	**1.07±0.02^A**
M_4 (Sept.)	1.00±0.04	1.10±0.04	1.17±0.04	1.02±0.04	**1.08±0.02^A**
Means	**0.97±0.02^c**	**1.10±0.02^b**	**1.16±0.02^a**	**1.00±0.02^c**	**1.05±0.02**

* Means within each column and row having different letters are significantly different at p<0.05.

4. Body reactions (RR and ST):

The effects of different shade types and diurnal, monthly variations on skin temperature (ST, °C) and respiration rate (RR, resp./min.) are presented in Table (6).

The results of ST and RR showed significant (P< 0.01) differences between the shade types during the experimental period.

The shade-net had lower values of ST and RR than other shades followed by reed shade because of the lower temperature under shade-net and reed shades, while the G1 and G_4 had higher values than G_2 and G_3. Mohamed (1993) stated that there were little significant differences in ST for buffalo calves kept under two types of sheds, asbestos and giant reed. ST was affected strongly by

Table (6): Means ± SE of skin temperature (ST, °C) in different day times during summer months as affected by shade type.

Treatments	(Control group) G_1			(Reed group) G_2			(Shade-net group) G_3			(Additives group) G4			Means*
Day time / Months	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm	
M_1 (Jun.)	28.85±.21	35.28±.21	29.21±.21	26.40±.21	32.52±.21	27.74±.21	26.39±.21	32.60±.21	26.61±.21	28.46±.21	34.83±.21	28.88±.21	29.81±.23[B]
M_2 (Jul.)	30.27±.21	36.21±.21	30.41±.21	29.10±.21	35.33±.21	29.80±.21	28.44±.21	35.96±21	29.82±.21	29.72±.21	36.02±.21	30.11±.21	31.77±.23[A]
M_3 (Aug.)	30.36±.21	36.71±.21	30.20±.21	29.30±.21	35.84± .21	29.42±.21	28.39±.21	36.19±.21	28.49±.21	29.69±.21	36.46±.21	29.84±.21	31.74±.23[A]
M_4 (Sept.)	28.80±.21	35.23±.21	28.98±.21	26.38±.21	32.51±.21	27.25±.21	26.35±.21	32.57±.21	26.91±.21	28.47±.21	34.82±.21	28.74±.21	29.75±.23[B]
Means	29.57±.01[b]	35.85±.01[a]	29.70±.01[b]	27.79±.01[c]	34.05±.01[b]	28.55±.01[c]	27.39±.01[c]	34.33±.01[a]	27.96±.01[b]	29.09±.01[c]	35.54±.01[a]	29.39±01[b]	30.77±0. 15
General means	31.71±.05[a]			30.13±.05[c]			29.89±0.05[d]			31.34±0.05[b]			

Table (7): Means ± SE of respiration rate (RR) resp. / min., in different day times during summer months, as affected by shade type.

Treatments	(Control group) G_1			Reed group) G_2			(Shade-net group) G_3			(Additives group) G4			Means*
Day time / Months	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm.	7 am.	2 pm.	7 pm	
M_1 (Jun.)	51.16±.55	67.11±.55	52.08±.55	45.05±.55	63.32±.55	47.88±.55	44.92±.55	62.87±.55	46.56±.55	48.08±.55	65.12±.55	50.75±.55	53.74±.07[B]
M_2 (Jul.)	54.92±.55	70.64±.55	55.71±.55	49.16±.55	67.00±.55	51.84±.55	48.33±.55	66.67±.55	51.20±.55	52.72±.55	68.68±.55	54.36±55	57.60±.07[A]
M_3 (Aug.)	54.48±.55	70.64±.55	55.79±.55	49.04±.55	66.88± .55	51.44±.55	48.73±.55	66.67±.55	51.20±.55	51.92±55	68.65±.55	54.00±.55	57.45±.01[A]
M_4 (Sept.)	51.20±.55	66.16±.55	52.40±.55	45.05±.55	63.32±.55	47.44±.55	44.92±.55	63.31±.55	47.12±.55	47.72±.55	65.16±.55	51.07±.55	53.74±.07[B]
Means	52.94±.28[C]	68.64±.28[a]	53.99±.28[b]	47.08±.28[c]	65.13±.28[a]	49.65±.28[b]	46.73±.28[c]	64.88±.28[a]	49.02±.28[b]	50.11±.28[c]	66.90±.28[a]	52.54±.28[b]	55.63±. 20
General means	58.52±.31[a]			53.95±.31[c]			53.54±.31[c]			56.52±.31[b]			

*Means within each column or row having different letters are significantly different at p<0.01

diurnal changes (8.00 am and 2.00 pm) and seasonal changes (4 seasons). El-Nouty (1996) found that thermal stress causes a rise in core temperature and activate heat loss mechanism via panting and sweating. The respiration rate was found to be the most sensitive physiological response to the environmental conditions than other physiological responses; the results emphasized the comfort of shade-net compared with asbestos and followed by reed shade. Kundu and Bhatnagar (1980) reported that the RR plays an important role in thermoregulatory mechanism amongst all the physiological reactions and body temperature comes next. The ST results of the four housing groups showed significant differences, as well. The results showed also significant diurnal differences (P< 0.01) among the three times of recording for ST and RR, there is a positive correlation between the three physiological parameters and THI. The highest values of ST and RR were obtained at 2.0 pm for the four groups, while the lowest values were obtained at 7.0 am. Shafie and El-Sheikh Aly (1970) reported that the increase in body reaction in Friesian cattle is the result of both gradual rise in atmospheric temperature and the variable increase in body activities of the animal. The present results showed also a monthly differences for ST and RR where July an August had higher values than June and September of the four groups. This result is in agreement with Salem (1966) who found that, in Friesian cows, a significant correlation between skin temperature and monthly temperature, the highest value of ST was 36.4 °C in April and the lowest value was 29.8 °C in December.

CONCLUSION

According to the results of this study, it could be concluded that keeping animals under shade-net or reed shades with well-ventilated area give better growth performance than keeping animals under asbestos shade even with nutritional additives and NPN.

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تأثير أنواع المظلات المختلفة كوسيلة لتخفيف الإجهاد الحرارى على استجابات الجسم وأداء النمو للعجول الخليطة

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إستخدم ١٠٠ ذكر خليط فريزيان – بلدى فى عمر حوالى ٩– ١٠ أشهر بمتوسط وزن حوالى ٢١٨ كجم، تم اختيارهم وتقسيمهم فى أحد المزارع الخاصة إلى أربع مجموعات متساوية، كل منها تم تربيتها منفصلة فى ملاعب ذات أرضية ترابية تحت النظام الحر نصف المظلل ، فى فصل الصيف (من يونيو إلى سبتمبر) . المجموعة الأولى غطيت مظلتها بشبك الظل (لدائن بولى إثيلين معامله فى صورة أقمشة شبكية) ، والمجموعة الثانية غطيت مظلتها بحصائر الغاب ، والمجموعة الثالثة غطيت مظلتها بالإسبستوس وزودت علائقها بإضافات غذائية مكونة من مخلوط أملاح معدنية ويوريا . هذه المجموعات الثلاثة قورنت بمجموعة (المقارنة) والتى غطيت مظلتها بالإسبستوس فقط. تم تسجيل الزيادة فى وزن الجسم (BWG) كذلك سجل الماء والغذاء المستهلك، لحساب الماء المتناول والمادة الجافة المأكولة (DMI,WI) كذلك حسب جدول العبئ الحرارى (THI) فى صورته العظمى والصغرى من خلال تسجيل درجات الحرارة والرطوبة بصورة يومية، بالإضافة لذلك تم تسجيل درجة حرارة أسطح المواد المختلفة المستخدمة فى التظليل ، وحرارة الأرضية أسفل المظلة. كذلك سجل كلٌ من درجة حرارة الجلد ومعدل التنفس ثلاث مرات يومياً. وقد أظهرت النتائج أن لنوع المظلة تأثير معنوى كبير على كل من معدل النمو اليومى والكفائة الغذائية (FU) والغذاء والماء المتناول ، ودرجة حرارة الجلد (ST) ومعدل التنفس(RR). وكان هناك إرتباط عالى المعنوية بين إستجابات الحيوان الجسمانية والظروف الجوية المحيطة. وتلخيصاً لما سبق، يمكن القول بأن تربية الحيوان تحت مظلة من شبك الظل أو الغاب وتحت ظروف تهوية جيدة يحقق أداء ونمو أفضل للحيوان مقارنة بتربيته تحت المظلات الإسبستوس حتى مع تزويد الحيوان بالإضافات الغذائية ومصدرللنيتروجين غير البروتينى حيث ذلك لم يحسن بصورة معنوية إستجابات الحيوان الجسمانية وكذلك نموه .