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Effect of Dehydration and Salt Stress in Chickens on Behavioral and Physiological Responses Reflected on EGG Production

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THE present study was carried out on 100 adult L.S.L. hens. The experiment included two seasons (summer and winter). Birds were divided into five groups. Water was available ad libitum in the first group (control group, G1), while in the second group (G2) water was with held (dehydrated group). In the forth (G4), third (G3) and fifth (G5) groups distilled water was offered ad libitum in which 1.0%, 0.5% and 0.0% NaCl was added in the respective order. After 6 days from the beginning of the treatments, total body water (TBW) and extracellular fluids (ECF) were measured and the intracellular fluids (ICF) were calculated by subtraction. Body weight (BW), food (Fc) and water (Wc) consumption, egg production (Ep),ambient temperature (Ta), rectal temperature (Tr) and respiration rate (RR) were determined daily during the experimental period.

Water deprivation (G2) decreased TBW significantly due to a significant reduction in ICF especially in summer, while in winter there was a significant reduction in both ICF and ECF. In both seasons, water deprivation decreased significantly Tr, RR, EP and Fc.

There was no significant difference between group 1 and 5 in all measurements. However, drinking distilled water tended to decrease Fc and Wc slightly, which decreased the TBW expressed as percentage from body weight. Addition of NaCl in drinking water by 0.5% and 1.0% affected most of the above parameters and the effects were discussed.

Keywords: Chicken, Egg, Salt stress, Dehydration, Response.

Scarcity of fresh water both for human and animal consumption is one of the vital problems in arid desert areas in Egypt and elsewhere. The recent horizontal expansion of rural communities in arid region had added to the realization of importance of fresh water especially in the newly reclaimed lands in Egypt.

Decreased water consumption is one of the major factors which induce changes in total body fluid and its distribution in the animal body.

The effect of restricted water intake on physiological processes, productivity and body fluid distribution in chickens had been studied previously in Egypt by Ali *et al* (1981); Amer *et al* (1984) and Khalil *et al* (1985).

This work was carried out to study the response of L.S.L. layers to water deprivation as well as to increasing concentration of salt in drinking water in different seasons on body fluid compartments and some vital physiological parameters.

Material and Methods

The present study was carried out on 100 white Lohman Selected Leghorn (L.S.L.) hens 15 months old. At the beginning of the experiment, the average body weight was 1651.66 ± 88.32 gm. in the summer (August and September) and 1546.60 ± 88.55 gm. in the winter (December and January). The experimental animals were maintained at the Poultry Experimental Station of Animal Production Department, Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt.

Birds were housed in floor pens (10 birds / $7m^2$ / pen) during the whole experimental period. All birds were healthy and clinically free from disease. All birds were fed a laying ration containing 16% protein and 2800 Kcal / Kg ME. Food and water were offered ad libitum at each seasonal experiment, normal daily feed and water intakes were recorded for 3 weeks before treatments started and also daily thereafter.

In each season, the experimental chickens were divided randomly into five treatment groups each of 10 hens. Each group was put under its particular drinking water treatment for 8 days. The first grop (G1) served as control and received water and food ad libitum. The second group (G2) was deprived of water (dehydrated group).

The third (G3), forth(G4) and fifth (G5) groups received distilled water containing 0.5% NaCl , 1.0% NaCl, and 0%NaCl, respectively. All birds in the five groups were fed the same ration.

Blood samples were withdrawn from the jugular vein after 6 days from the start of the treatments to determine body fluids in each season. Samples were taken after 1, 2, 4 and 12 hrs. and every 12 hrs. thereafter, until the end of the experiment (eighth day).

Total body water was determined using tritiated water (Yousef *et al.*, 1970). The plasma samples were assayed for tritium using liquid Scintillation Spectrometer. Total body fluid was calculated as described by Aschbacker *et al.* (1965). The extracellular fluid (ECF) was estimated by sodium thioscianate method as described by Weiss (1958) and by Medway and Kare (1959). The intracellular fluids (ICF) was calculated by subtraction of ECF from TBW.

Body weight (BW), food (Fc) and water (Wc) consumption, egg production (Ep), ambient temperature (Ta), rectal temperature (tr), skin temperature (Ts) and respiration rate (RR) were determined daily during the whole experimental period. Rectal temperature (Tr) was measured using a Yellow Spring Instrument (telethermometer). Changes in Tr were used as indices of changes in the average temperature of the deep tissues (Ali *et al.*, 1981 and Abd-El-Hakim *et al.*, 1986). Ambient temperature (Ta) was measured using thermograph. Respiration rate (RR) was measured by counting chest movements per minute.

Statistical analyses were carried out according to Winer (1971). Student t-test was used to test the effect of seasonality within each treatment, while Duncan's Multiple Range Test was run to test the significance between each two groups within each season.

Results and Discussion

1. Feed and Water Consumptions

The average feed consumption in the normal group was 139.563 gm. / bird / day in summer and 146.60 gm. / bird / day in winter (Table 1). This result agrees with those obtained by Sykes and Fataftah (1986) who found that feed consumption is negatively related to ambient temperature. A reversed trend was found with water consumption. In the normal group, it was 222.373 ml. / bird / day in summer and 204.870 ml. / bird / day in winter. The positive relationship between Ta and Wc observed in the present study (Table 1) had been previously reported by Wilson and Edwards (1955) and Ito *et al* (1970).

TABLE (1). Mean of egg production (Ep%), feed consumption (Fc) (gm) and water consumption (Wc) (ml) of the different groups in summer and winter.

Trestment	E.p. (%)		F.c. (gm) / day		W.c. (ml) / day	
	summer	winter	summer	winter	summer	winter
Control group (G1)	46.2	53.0	139.5	146.6	222.3	204.8
Dehydrated group (G2)	8.9	17.8	63.7	69.6	-	-
0.5% NaC1 group G3)	36.2	43.0	121.5	127.4	226.6	218.5
1.0% NaC1 group (G4)	10.9	18.7	68.4	88.1	72.7	73.6
Dist. water group (G5)	30.0	45.0	134.0	144.8	202.0	185.5

Water deprivation in both summer and winter decreased feed consumption in laying hens (Table 1). Mcfarland and Wright (1969) explained the inhibition of food intake during water deprivation as a mean of water conservation. In many birds, body temperature also decreases if food intake is reduced, and it is possible that the reduction in food intake during water deprivation also serves to keep the body temperature (Tr) down, thereby conserving water which would otherwise be lost by evaporation. Scott *et al.* (1969), added that water deprivation reduces the rate of digestion by delaying the movement of food from the crop.

The results indicated that 0.5% NaCl and distilled water intake had no great effect on food and water consumption as compared to the control group, while water deprivation and 1.0% NaCl decreased food and water consumption and 1.0% NaCl decreased water consumption. Krista *et al.* (1961) found that in chicks, the rate of water consumption increased gradually from the control up to the 0.7% NaCl level, above which the rate of consumption gradually decreased.

2. Body Weight (BW)

In summer, the average body weights at the beginning of the treatments were 1840, 1634, 1772 , 1874 and 1934 gm. for groups 1, 2, 3, 4 and 5, respectively. After

6 days these figures were slightly lower (about 6% from initial weight) in the control (G1) and distilled water (G5) groups. However, in the third group (G3) which consumed 0.5% NaCl the reduction in body weight was 11.5% from its initial value (significant at $P<0.01$) (Table 2). While, a loss of 24% or more in body weight was occurred after 6 days of water deprivation (G2) or consuming 1% NaCl in water (G4) (Table 2) (signifact at $P < 0.01$), indicating that body weight loss increased with increasing the concentration of salt in drinking water. This reduction in body weight during water deprivation or salt stress was due to decreasing feed consumption and body water content. The water lost by evaporation is not replaced by water intake as stated by Arad (1983); Arad *et al.* (1983) and Khalil *et al.* (1985).

TABLE (2). Mean ± standard error of body weight (BW) of the different groups in summer and winter.

Treatment	Summer	Winter	t - test
Control group (G1)	a 1812.5 ± 112.9	a 1822.8 ± 47.7	NS
Dehydrated group (G2)	c 1357.3 ± 41.0	b 1384.9 ± 57.3	NS
0.5% NaCl group G3)	b 1670.2 ± 89.7	b 1455.2 ± 58.4	*
1.0% NaCl group (G4)	b 1574.0 ± 81.7	b 1383.8 ± 71.3	*
Dist. water group (G5)	a 1844.3 ± 41.7	c 1686.3 ± 30.4	**

NS = insignificant
* = significant at $p < 0.05$
** = significant at $p < 0.01$
t-test = t-test between summer and winter
a, b, c, = each two identical letters in the same column denote that there is no significant difference between the means.

Similar results were obtained in winter but the body weight loss was lower than that occurred in summer in all groups. This may be due to the increase in water loss through evaporation in summer which increased the loss in total body water (TBW) (as percentage from body weight) in summer than in winter (40.7%, 58% and 33.5% in summer versus 50.5%, 72.3% and 45.6% in winter for G2, G3 and G4, respectively). These results agree with those obtained by Richards (1977).

3. Body Fluid Compartments:

Total body water (TBW) represented 68% of body weight in both seasons (Table 3). Meanwhile, ECF and ICF comprised 21 and 47% of body weight in summer and 35 and 34% in winter, respectively (Table 3). Total body water in laying hens was found to range between 62 and 64% of body weight (Chapman and Black, 1967 and Amer *et al.*, 1984). Sturkie (1965) reported that extracellular fluid (ECF) comprised 30% of body weight of 16 week old leghorn pullets in which TBW was about 64.5% of body weight.

It is obvious that in control group ECF% was significantly lower in summer than in winter (21% versus 35% of body weight). This may be due to high water loss through panting in summer (Khalil *et al.* 1985).

TABLE (3). Mean ± standard error (in ml.) of total body water (TBW), extracellular fluid (ECF) and intracellular fluid (ICF) of the different groups in summer and winter.

Treatment	TBW (ml) Summer	TBW (ml) Winter	t. test	ECF (ml) Summer	ECF (ml) Winter	t. test	ICF (ml) Summer	ICF (ml) Winter	t. test
(G1) control group	a 1232.470 ± 60.141	a 1254.330 ± 30.791	NS	a 381.08 ± 41.40	a 632.810 ± 57.463	**	a 851.390 ± 79.183	a 621.520 ± 52.100	NS
(G2) dehydrated group	c 551.870 ± 17.502	c 698.690 ± 25.130	NS	b 267.880 ± 10.944	b 299.290 ± 12.922	NS	b 283.990 ± 24.602	b 399.400 ± 30.296	NS
(G3) 0.5% NaCl group	b 968.910 ± 50.961	b 1051.540 ± 55.633	NS	b 303.880 ± 14.735	c 516.920 ± 49.056	**	a 665.030 ± 41.519	a 534.620 ± 20.061	NS
(G4) 1.0% NaCl group	c 527.100 ± 34.324	c 630.910 ± 16.900	NS	b 311.550 ± 13.382	b 262.460 ± 12.150	NS	b 215.550 ± 29.507	b 369.450 ± 10.573	**
(G5) Dist, water group	a 1155.280 ± 35.464	ab 1119.510 ± 25.674	NS	a 368.200 ± 58.692	a 669.690 ± 31.493	**	a 787.080 ± 63.586	a 449.820 ± 28.056	**

NS = Not significant
* = Significant at P <0.05
** = Significant at P < 0.01
t-tes = t-test between summer and winter
a,b,c, = each two idnetical letters in the same column denote that there in no significant difference between the means.

Table (3) indicates that, in summer, TBW decreased significantly in the water deprived (G2), 0.5% NaCl (G3) and 1.0% NaCl (G4) groups. However, the reduction was more pronounced in water deprived and 1% NaCl groups than in 0.5% NaCl group.

Similar results were found by Romanoff and Romanoff (1949) and Amer *et al* (1984), who reported that water deprivation (48 hrs.) decreased total body water (TBW) by about 10% to 13.5%. Also Ali *et al.* (1981) found that dehydration due to the use of salt water decreased total body fluids in Fayoumi hens and the reduction was more pronounced as the level of salt stress increased.

In winter, similar results were found but the effect of dehydration was slightly lower than that occurred in sumer, (Table 3). So, in winter the total body water as a percent of body weight (TBW%) of the 0.5% NaCl group (G3) did not differ significantly from that of the control group (G1) or distilled water (G5) group.

In summer, dehydration had no significant effect on ECF% expressed as percentage of body weight (Table 3). However, ICF% decreased significantly in water deprived and 1.0% groups. As a result, the decrease in TBW during water deprivation and 1.0% NaCl was mainly due to the reduction in ICF rather than ECF. this result agrees with Gee and Huston (1965) who found that the reduction in total body water during water deprivation was due mainly to a reduction in intracellular fluid. Moreover, birds consuming 1.0% NaCl had slightly lower ICF% of their body weight than the water deprived ones (13.7 versus 20.9% respectively). This may be due to higher blood osmotic pressure in the 1.0% NaCl group than that in the water deprived one which will increase water outflow from intracellular to extracellular portion. Harper *et al* (1979) suggested that the loss in ICF during dehydration was probably due to the outflow of such fluids from the cell to surrounding hypertonic ECF. The ICF% of body weight in the 0.5% NaCl group was closer to that of the normal control group (47.0 and 39.8%, respectively). It can be concluded that the addition of NaCl to drinking water up to 0.5% was of insignificant effect on the body fluid distribution while 1.0% caused a significant reduction in intracellular volume. Ali *et al.* (1981) found that increasing the percentage of sea water in drinking water from O to 50% had a slight effect on TBW, ICF and ECF expressed as percentage of body weight. However, increasing sea water to 75% decreased TBW and ICF while ECF increased.

In winter, the significant reduction in TBW expressed as percentage of body weight during water deprivation and 1.0% NaCl was due to a significant reduction in both of ICF% and ECF% (Table 3). The ECF% was lower in dehydrated groups than in the normal ones, while it did not differ significantly in summer this may be- due to the effect of heat which increases ECF. More and Sahni (1979) found that extracellular fluids were significantly higher during hot season than in winter.

4. Rectal temperature (Tr).

In the summer experiment, although Tr of the normal group increased significantly by 1.6% after 6 days from the beginning treatments, the Tr of the dehydrated group (G2) and that which consumed 1% NaCl (G4) decreased significantly ($P < 0.05$) by 2.1% and 1.6%, respectively. While, it decreased slightly by 1.1% in the third group. As a result, Tr was significantly lower in G2, G3 & G4 than in the normal group (Tables 4 & 5). Similar results were found in water deprived birds by Sturkie (1965), Mcfarland and Wright (1969), Amer *et al.* (1984) and Khalil *et al* (1985) and in birds drinking salt water by Kellarup *et al.* (1965) and Ali *et al* (1981). Moreover, Khalil *et al.* (1985) explained that the reduction in body temperature during dehydration may be due to the reduction in basal metabolic rate obtained by the inhibition of thyroid function which inturn due to the reduction in its water content as an adaptive mechanism for water conservation.

In winter, a similar trend was found (Tables 4 & 5), but is tend to decrease slightly in all dehydrated groups except in the water deprived group (G2) when the reduction was statistically significant ($P < 0.05$) (2.7%). So, the effect of salt stress (1% Na Cl in drinking water) on Tr was more obvious in summer than in winter.

In all groups. Tr did not differ significantly between summer and winter. Azahan and Sykes (1980) reported that increasing ambient temperature (Ta) from 20°C to 29 or 32°C did not affect significantly rectal temperature of fowls. Meanwhile, the average Ta during the present experiment was 29.5°C and 18.4°C in summer and winter, respectively, which was almost in the same range of that of Azahan and Sykes (1980).

The above results indicate that the effect of salt stress on is affected mainly by ambient temperature (Ta) while water deprivation had a similar effect in both seasons. Edens (1976) demonstrated that the Na^+ cations affect body temperature regulation in the chicken, but the effect appeared to be dependent upon environmental temperature. He added that at 24°C Na^+ had no significant effect on body temperature, while in the hot environment (45°C) it potentiated the heat induced hyperthermia.

TABLE (4). Means ± SE of rectal temperature (Tr) and respiration rate (RR) of the different groups in summer and winter.

Treatment	Tr (°C)			RR (r/min)		
Season	Summer	Winter	t. test	Summer	Winter	t. test
(G1) control group	a 41.940 ±0.102	a 40.940 ± 0.163	NS	a 42.400 ±1.790	a 40.500 ± 1.302	NS
(G2) dehydrated group	b 39.550 ± 0.332	b 39.360 ± 0.335	NS	c 16.710 ± 0.944	c 15.630 ± 0.498	NS
(G3) 0.5% NaCl group	b 39.960 ± 0.111	a 40.600 ± 0.171	NS	b 32.000 ± 1.578	b 30.000 ± 0.699	NS
(G4) 1.0% NaCl group	b 39.500 ± 0.189	a 40.280 ± 0.280	NS	c 18.600 ± 0.655	c 18.750 ± 0.491	NS
(G5) Distilled water group	a 41.480 ± 0.144	a 40.900 ± 0.228	NS	a 44.800 ± 1.960	a 43.800 ± 2.138	NS

NS = Not significant
t.test = t.test between summer and winter
a, b, c, = each two identical letters in the same column denote that there is no significant difference between the means.

5. Respiration Rate (RR)

The average respiration rate of normal birds was about 49 r.p.m. in summer and 46.3 r.p.m. in winter (Table, 4). In summer, RR decreased significantly ($P < 0.01$) in groups 2, 3 and 4 by 55.8, 34.3 and 53.7%, respectively, while in group 1 and 5 there was a slight increase in RR (about 13 and 10%, respectively) (Table 5). The same changes was found in winter except that RR in group 1 and 5 decreased by 12.5% and 3%, respectively. The reduction in RR during water deprivation will reduce both water loss through respiratory evaporation and oxygen consumption (*i.e.* heat production) which is one of the well known adaptive mechanisms against dehydration (Khalil *et al.*, 1985).

TABLE (5). Percentage change in rectal temperature (Tr); respiration rate (RR) and body weight (BW) of norm during each two successive intervals in summer and winter.

Treatment	interval (days)	summer Tr (%)	summer RR (%)	summer BW (%)	winter Tr (%)	winter RR (%)	winter BW (%)
(G1)	0 - 3	-0.686	-14.175	1.957	1.263	7.343	-1.120
control	3 - 6	-0.876 *	-4.289	4.157	0.689	3.263	-2.042
group	0 - 6	-2.794 **	-13.115 *	-6.033 *	1.891 *	-12.527 *	-0.924
(G2)	0 - 3	-1.139	-27.078 *	-12.378 **	-0.297	-39.631 **	-15.645 **
dehydrated	3 - 6	-3.426 *	-41.507 *	-13.022 **	-2.992 **	-39.122 **	-12.701 **
group	0 - 6	-2.945 *	-55.841 **	-27.173 **	-2.671 *	-53.204 **	-26.273 **
(G3)	0 - 3	-2.673 **	-10.417 *	-5.756 **	0.197	19.734 **	7.035 **
0.5% NaCl	3 - 6	-3.664 **	-25.926 **	-6.048 **	-0.493	17.127 **	2.112 *
group	0 - 6	-2.155	-34.292 **	-11.456 **	-1.099	-33.481 **	-9.011 **
(G4)	0 - 3	2.141 *	18.159 **	-10.832 **	-0.370	-32.273 **	-11.519 **
1.0% NaCl	3 - 6	3.169 **	20.912 **	-18.517 **	-1.445	-38.188 **	-11.206 **
group	0 - 6	-2.091 *	-53.731 **	-24.173 **	-0.641	-51.425 **	-20.745 **
(G5)	0 - 3	-1.980 **	-6.880 *	2.751 **	-1.096	-11.894 **	-1.226
Distilled	3 - 6	1.748 **	-6.413	3.328 *	-0.789	-9.500	-3.712 **
water group	0 - 6	0.193	-8.008 *	-5.998**	-1.893	-3.524	-2.527

* = Significant at $P < 0.05$
** = Significant at $P < 0.01$

6. Egg Production (EP)

The average egg production of normal group was reduced to 46.25 percent in summer compared with 53.0 percent in winter (Table, 1) which was due to the effect of high temperature. Kamar and Khalifa (1964) found that the increase in body temperature during late summer reduced egg production, while the decrease in body temperature to its lowest values was associated with the maximum egg production.

Water deprivation decreased egg production to 8.93% in summer and 17.88% in winter (Table, 1). Increasing NaCl in drinking water to 0.5% NaCl caused a small reduction in egg production by about 10%. Meanwhile, 1.0% NaCl decreased egg production to levels near that of the water deprived group (11.0% and 18.8% in summer and winter, respectively). Krista *et al* (1961) found that a significant drop in egg production occurred at 1.0% NaCl in tap water, while 0.4% and 0.7% had no significant effect. Ali *et al* (1981) found that egg production was reduced by increasing the proportion of sea water in drinking water.

7. Mortality Rate

The percentage of mortality was higher in dehydrated and the 1.0% NaCl groups than in the other groups in both seasons, but the effect was more pronounced in summer (70% and 50% in summer and 50% and 40% in winter for G2 and G4, respectively versus 0% in other groups). However, water deprivation caused a slightly more mortality rate than 1.0% NaCl especially in summer (70% versus 50%). Spiller *et al* (1976) suggested that this was mainly due to higher reduction in total body solids because of more reduction in feed intake in the water deprived group or in 1.0% NaCl one.

It is concluded that the effect of 1% NaCl in drinking water was similar to that of water deprivation, while 0.5% NaCl did not affect greatly most of the studied traits especially in winter. So, if there is no enough water for drinking, salinity up to 0.5% NaCl can be used without serious effect.

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دراسة تأثير العطش وملوحة المياه على السلوك الفسيولوجى وأنتاج البيض فى الدجاج

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قسم الأنتاج الحيوانى ـ كلية الزراعة ـ جامعة الأزهر . مدينة نصر ـ القاهرة.

اجريت هذه الدراسة على ١٠٠ دجاجة ل . س. ل. لمعرفة تأثير العطش سواء بمنع الطائر عن الشرب أو عن طريق أضافة كلوريد صوديوم نقى فى مياه الشرب بنسب مختلفة على توزيع سوائل الجسم وبعض الصفات الفسيولوجية فى المواسم المختلفة.

تم تقسيم الطيور الى خمس مجموعات حيث كان الغذاء متوافراً حسب احتياجات الطائر فى كل المجاميع وهى:

المجموعة الأولى : وهى المجموعة المقارنة حيث توفر الماء امام الطيور والمجموعة الثانية: منع عنها الماء (المجموعة المعطشه). والمجموعة الثالثه: تشرب مياه مقطره بها ٥ ٠. ٠٪ كلوريد صوديوم نقى. والمجموعة الرابعة : تشرب مياه مقطره بها ١٪ كلوريد صوديوم. والمجموعة الخامسة والاخيرة: كانت تشرب مياه مقطره ، وكان عدد الطيور فى كل مجموعة عشرة دجاجات.

وقد أظهرت الدراسة النتائج التاليه:

١ – ادى منع الماء كلية الى خفض معنوى فى درجة حرارة المجمع ومعدل التنفس وانتاج البيض. كما ادى الى خفض كمية الغذاء الماكول ، وكانت النتائج اكثر وضوحا فى موسم الصيف عنها فى موسم الشتاء. كما ادى منع الماء الى نقص وزن الجسم نتيجة الى نقص حجم الماء الكلى وذلك نتيجة لنقص الماء داخل الخلايا الا ان درجة الحرارة كان لها تأثير حيث ان نقص الماء الكلى كان راجعا الى نقص الماء داخل الخلايا فى موسم الصيف بينما نجد انه عند انخفاض درجة الحراره شتاء كان نقص الماء الكلى راجعا الى نقص فى كل من الماء داخل وخارج الخلايا.

٢ – اظهرت المجموعة التى كانت تشرب مياه مقطره بها ١٪ كلوريد صوديوم نتائج مشابهه الى المجموعة المعطشة اما فى الصيف فقد ادى شرب مياه بها ٠,٥٪ كلوريد صوديوم الى نقص معنوى فى الماء الكلى نسبه من وزن الجسم والذى كان نتيجة الى نقص غير معنوى فى الماء داخل وخارج الخلايا كذلك فأن شرب مياه مقطره بها ٠,٥٪ كلوريد صوديوم ادى الى خفض قليل فى الماء والغذاء المتناول عن المجموعة المقارنه خاصة فى موسم الصيف وخفض معنوى فى درجة حرارة المجمع ومعدل التنفس .

٣ – اظهرت نتائج المجموعة التى شربت ماء مقطر نتائج مشابهه للمجموعة المقارنه إلا ان معدل تناول الغذاء وشرب الماء المقطر كان اقل بدرجة غير ملحوظة عن المجموعة المقارنة مما ادى الى نقص قليل فى الماء الكلى كنسبه من وزن الجسم عن المجموعة المقارنه والذى كان نتيجه لنقص فى كل من الماء داخل وخارج الخلايا .