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Changes In The Nucleic Acids Metabolism In *Uromastyx microlepis* During The Entry, Deep And Arousal Phases of Hibernation

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Abstract. Studies were carried out to explore the nucleic acid profile in different tissues of the hibernating reptile spiny-tailed lizard, *Uromastyx microlepis*. Also, the changes in alkaline phosphatase and 5'- nucleotidase enzymes activity in serum and different tissues during the different phases of the hibernating cycle in the *Uromostyx* were studied. The data obtained are as follow:- The present results revealed the occurrence of initial elevations in DNA content of different tissues of animal in preparation for hibernation followed by a continuous decline during hibernation. The decline recorded in the DNA content reflect the occurrence of decreased rate of biosynthesis of DNA of different tissues in *Uromostyx* during the hibernating season. The analysis of RNA revealed that hibernation caused a significant decline in its content in liver and kidney of animal. Conversely, brains did not follow that profile, whereas in hibernating *U. microlepis,* brain RNA increased and was maintained at high level till arousal. The alkaline phophatase activity declined in hibernation in serum and different tissues of *Uromastyx* and restored its activity on arousal. The data indicate a close correlation between the DNA profile and the changes recorded for alkaline phosphatase, which plays the important role of furnishing the required mononucleotide, in preparation for hibernation followed by a declining activity during deep hibernation. The 5´- nucleotidase activity of liver and kidney showed an initial decline in preparation for hibernation followed by an increase on hibernation and declined on arousal to the active level especially in liver. In serum and brain, 5´- nucleotidase exhibited a continuous decline during the hibernating cycle, which restored its activity on arousal to reach the active level. The data indicate that nucleic acids assume optimum concentrations allowing the animal to maintain a minimal control over protein metabolism.

Key word: DNA- RNA- Alkaline phophatase- 5'-Nucleotidase- Hibernation- *Uromastyx microlepis.*

Introduction

Hibernation is a form of hypothermic dormancy that allows animals to escape unfavourable climatic regimes and periods of unavailable food resources. Because the metabolic rate of a tissue is reduced when the tissue temperature is reduced hypothermia reduces the thermostatic component of an animal energy budget.

Hibernation in reptiles is regarded as a crucial step in their life history. In reptiles it is characterized mainly by anorexia, dormancy and depression of metabolic rate. (Okasha *et al.,* 1988; Abdel-Raheem *et al.,* 1989 a, b and c; El Daly *et al.,* 1995 and Abdel-Kader *et al.,* 1995). This reduced metabolic rate has been shown to be an important strategy in energy conservation in reptiles (Johanson and Lykkeboe,1979; Abdel-Raheem et al., 1989 a, b and c ; El Daly *et al,,* 1995 and Abdel-Kader *et al.,* 1995).

Comparatively little information is available about the metabolic profile of nucleic acids in hibernating animals. Adelstein *et al.,* (1964) found that the DNA synthetic activity in hibernating dormouse (*Glis glis*) is 24 times lower than in the active animals, and the DNA synthesis seems to continue during the bout of hibernation. Suomalainen and Oja (1967) have reported a marked depression of the mitotic

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index in the intestine of hibernating hedgehogs and flourishing of mitosis was observed on periodic arousals. It was found that the mitotic index in gastric mucosa epithelium (Vinogradova, 1982) and in bone marrow (Unker and Alekseeva, 1974) was greatly reduced during hibernation and rose after arousal in the ground squirrel (*Citellus erythrogenous*). Studies were also performed on the RNA and both the total and basic protein content of individual cells in neurons and perineuronal oligodendroglia of the hypothalamic supraoptic nucleus in rats as well as in ground squirrels (Pevzner, 1981).

Moreover, studies on the snake *Eryx colubrinus* and the lizard *Eumeces schneideri* during the entry, deep and arousal phases of hibernation revealed that DNA and RNA content in different tissues of animals exhibited a decline in the deep hibernation (Abdel Raheem *et al.,* 1989 a). Also, the last authors reported that alkaline phosphatase declined in hibernation and restored its activity on arousal in both studied hibernating animals. On the other hand, the 5´- nucleotidase activity increased in hibernation especially in livers and kidneys of *E. colubrinus* and *E. schneideri.*

In view of the lack and scarcity of informations on nucleic acid metabolism in hibernating reptiles and in view of our findings of the disturbed protein metabolism (Okasha *et al.,* 1988 and Abdel-Raheem *et al.,* 1989 a and c) in reptiles the present work was undertaken to study the nucleic acid profile in the spiny-tailed lizard, *Uromastyx microlepis.*

Materials and Methods

The animal used in the present study was the spiny-tailed lizard *Uromastyx microlepis*. this lizard is a reptile that inhabits the deserts of North Africa and Arabia, it is known by the local name of "dabb" in Saudi Arabia and the adult animals were caught from desert area of Al-Qassim region in the middle of Kingdom of Saudi Arabia. They were brought directly to the laboratory, from their natural habitats. Specimens were divided into four groups based on the seasons when the animals were collected : active animals (summer: June, July), prehibernating animals (fall: late October, November), hibernating animals (winter: December, January) and arousing animals (spring: late March, beginning of April).

Animals were sacrificed by decapitation, blood was collected in clean centrifuge tubes and serum was prepared after clotting by centrifugation at 3000 r.p.m. for 20 min. Sacrificed animals were immediately dissected on a cold plate to remove the tissues studied in the present investigation. The tissues studied were liver, kidney and brain. Accurately weighed tissues were homogenized in ice-cold bidistilled water (1: 10 dilution) using a potter El-Vejhem glass homogenizer fitted with a Teflon pestle. The freshly prepared homogenates were then used for determination of nucleic acids, alkaline phosphatase and 5´-nucleotidase assays immediately or stored at -20 ^{o}C in the deep freezer till ready for biochemical studies.

Quantitative separation and identification of nucleic acids (DNA and RNA) were carried out according to the modified method of Shibko *et al.* (1967). Enzyme assay for alkaline phosphatase activity was made using reagent kits from Bio-Analytics Company (P.O. Box 388, Palm city, Fl. 34990), with Catalog No. 23001, 2. 5´-Nucleotidase activity was measured according to the method of El-Aaser and El-Merzabani (1975).

Statistical analysis: Results are expressed as mean ± SE. Data were analyzed by one-way analysis of variance (ANOVA) followed by Student"s *t*- test using the Statistical Package for the Social Sciences (SPSS) version 10. Differences with $P<0.05$ were considered significant.

Results

(i) Deoxyribonucleic Acid (DNA)

The seasonal variations in the DNA content of the three major organs, liver, kidney and brain were examined in lizard *Uromastyx microlepis* which undergoes hibernation (Table 1).

During prehibernation, liver DNA of *U. microlepis* increased significantly ($P<0.01$) with warm to cold acclimation exhibiting value of 141.26 % of active animals. On the other hand, during deep hibernation the hepatic DNA was drastically affected, where a significant ($P<0.01$) decline with a value of 75.34 % of active animals was noted. The decline recorded in hepatic DNA during winter months was retained and significant ($P<0.05$) during arousal where a value of 88.34 % of active animals was recorded.

Table 1. Changes in the deoxyribonucleic acid (DNA) content of the different organs of *Uromastyx microlepis* during the different phases of the hibernating cycle.

Tissue	Period	Mean ± S.E. (mg/g. tissue)	% of active
Liver	active	0.446 ± 0.017	---
	Prehibernating	0.630 ± 0.027	141.26**
	hibernating	0.33 ± 0.017	75.34**
	arousal	0.394 ± 0.008	88.34*
Kidney	active	0.224 ± 0.009	---
	Prehibernating	0.338 ± 0.019	150.89**
	hibernating	0.132 ± 0.011	58.93**
	arousal	0.184 ± 0.009	82.14*
Brain	active	0.140 ± 0.007	---
	Prehibernating	0.200 ± 0.007	142.86**
	hibernaing	0.092 ± 0.006	65.71***
	arousal	0.114 ± 0.005	81.43*

Values represent the mean ± S.E. of five animals per group.
*P<0.05; **P<0.01; ***P<0.001 compared to active (control) group by Student's *t*-test.

Considering the cyclic changes in the DNA content of kidneys of *U. microlepis,* it exhibited a significant (P<0.01) increase of 150.89% of active animals during prehibernation. Conversely, a sharp decrease of kidneys DNA content was observed during deep hibernation where a value of 58.93 % relative to active animals concentration was recorded which was statistically significant (P<0.001). The content of DNA in kidneys rose rapidly, signaling that arousal had begun. However, it was lower than the active concentration, showing a value of 82.14 %. The value recorded is significantly different from the active animals (P<0.05).

As seen from the data, there is a pronounced significant (P<0.01) elevation of the concentration of DNA in brain of prehibernating animals. The value (expressed as a percentage of active animals) was 142.86 %. Conversely, when animals were passed to deep hibernation a higher significant (P<0.001) decline in brain DNA content of 34.29 % was noted. Arousing animals manifested a significant (P<0.05) decline in brain DNA content of 18.57 %.

(i i) Ribonucleic Acid (RNA)

The concentrations of RNA in liver, kidney and brain of *U. microlepis* were studied during the different phases of hibernating cycle (Table 2).

Studying the hepatic RNA content, the data obtained indicate that, it exhibited non-signifcant (P>0.05) increase during prehibernation. The value recorded and calculated as a percentage of active was found to be 111.85%. On the other hand, a significant (P<0.01 and P<0.05) declines of 24.55% and 18.78% were recorded during hibernation and arousal respectively.

The changes occurring in the RNA level in kidneys of *U. microlepis* showed that animals exhibited a significant (P<0.001) increase of 21.93% in animals preparing for hibernation. Conversely, the kidneys of hibernating animals suffered from a significant (P<0.05) decline in their RNA content of 12.42%. The results obtained demonstrated the occurrence of a non-significant (P>0.05) small and limited decline of 2.44 % in kidney RNA content during arousal.

The analysis of RNA content in brain of *U. microlepis* reveals the occurrence of significant (P<0.01 and P<0.001) and non-significant (P>0.05) increases of 42.52%, 27.53% and 11.38% during prehibernation, hibernation and arousal respectively.*(i i i) Alkaline Phosphatase*

The cyclic changes in the activity of the enzyme alkaline phosphatase was measured in sera, livers, kidneys and brains of *U. microlepis* (Table 3).

The alkaline phosphatase activity in serum during prehibernating season reflect the occurrence of non-significant (P>0.05) increase of 9.24%. Conversely, the serum enzyme activity declined

Table 2. Changes in the ribonucleic acid (RNA) content of the different organs of *Uromastyx microlepis* during the different phases of the hibernating cycle.

Tissue	Period	Mean ± S.E. (mg/g. tissue)	% of active
Liver	active	1.874 ± 0.071	---
	Prehibernating	2.096 ± 0.070	111.85
	hibernating	1.414 ± 0.033	75.45**
	arousal	1.522 ± 0.028	81.22*
Kidney	active	1.642 ± 0.025	---
	Prehibernating	2.002 ± 0.052	121.93**
	hibernating	1.438 ± 0.035	87.58*
	arousal	1.602 ± 0.029	97.56
Brain	active	0.334 ± 0.016	---
	Prehibernating	0.476 ± 0.015	142.52**
	hibernaing	0.426 ± 0.014	127.55***
	arousal	0.372 ± 0.019	111.38

Values represent the mean ± S.E. of five animals per group.
*P<0.05; **P<0.01; ***P<0.001 compared to active (control) group by Student's *t*-test.

Table 3. Changes in alkaline phosphatase activity of serum and differnt organs of *Uromastyx microlepis* during the different phases of the hibernating cycle.

Tissue	Period	Mean ± S.E. (mg/g. tissue)	% of active
Serum (I.U. / 100 ml)	active	9.766 ± 0.272	---
	Prehibernating	10.668 ± 0.297	109.24
	hibernating	5.922 ± 0.236	60.64**
	arousal	7.900 ± 0.257	80.89*
Liver (I.U. / mg. prot. hr.)	active	4.668 ± 0.128	---
	Prehibernating	6.254 ± 0.170	133.98**
	hibernating	3.878 ± 0.096	83.08**
	arousal	6.886 ± 0.247	147.52***
Kidney (I.U. / mg. prot. hr.)	active	6.432 ± 0.207	---
	Prehibernating	7.414 ± 0.140	115.27*
	hibernaing	1.578 ± 0.067	24.53***
	arousal	7.658 ± 0.205	119.06*
Brain (I.U. / mg. prot. / hr.)	active	0.318 ± 0.014	---
	Prehibernating	0.386 ± 0.012	1211.38
	hibernating	0.232 ± 0.008	72.96**
	arousal	0.326 ± 0.009	102.52

Values represent the mean ± S.E. of five animals per group.
*P<0.05; **P<0.01; ***P<0.001 compared to active (control) group by Student's *t*-test.

significantly (P<0.01 and P<0.05) in hibernating and arousing animals showing values (expressed as a percentage of active) of 60.64% and 80.89% respectively.

The analysis of alkaline phosphatase activity in liver of *U. microlepis* during the different phases of the hibernating cycle shows the occurrence of significant (P<0.001) elevations of 33.98% and 47.52% in prehibernation and arousal respectively. On the other hand, the hepatic alkaline phosphatase activity significantly (P<0.01) declined in hibernating animals by a value of 16.92%.

Studying the alkaline phosphatase activity of kidney, the data obtained indicate that, it exhibited significant (P<0.05) increases during prehibernation and arousal. The values recorded and calculated as a percentage of active were found to be 115.27% and 119.06% respectively. Conversely, hibernating animals exhibited an alkaline phosphatase activity which was 75.47% lower than in summer animals.

The alkaline phosphatase activity in brain of *U. microlepis* exhibited non-significant (P>0.05) elevations during prehibernation and in arousal. The value (as a percentage of active) were 121.38% and 102.52 % respectively. On the other hand, a significant (P<0.01) decrease of 27.04% was recorded during hibernation.

(iv) 5′-Nucleotidase

The activities of 5′-nucleotidase in serum, liver, kidney and brain of *U. microlepis* were studied during the different phases of hibernating cycle (Table 4).

The serum level of 5′-nucleotidase of *U. microlepis* exhibited significant (P<0.001) decreases during the different phases of hibernating cycle. The values (expressed as a percentage of active animals) were 64.76 %, 47.98% and 52.63% during prehibernation, hibernation and arousal respectively.

During the prehibernating season, the hepatic 5′-nucleotidase activity recorded a significant (P<0.01) decline of 58.57% of active animals. Conversely, a

Table 4. Changes in 5'-nucleotidase activity of serum and different organs of *Uromastyx microlepis* during the different phases of the hibernating cycle.

Tissue	Period	Mean ± S.E. (mg/g. tissue)	% of active
Serum (I.U. / 100 ml)	active	17.828 ± 0.486	---
	Prehibernating	11.546 ± 0.213	64.76***
	hibernating	8.554 ± 0.210	47.98***
	arousal	9.382 ± 0.261	52.63***
Liver (I.U. / mg. prot. hr.)	active	0.56 ± 0.020	---
	Prehibernating	0.328 ± 0.019	58.57*8
	hibernating	1.192 ± 0.070	212.86***
	arousal	0.608 ± 0.036	108.57
Kidney (I.U. / mg. prot. hr.)	active	0.782 ± 0.022	---
	Prehibernating	0.338 ± 0.018	43.22***
	hibernaing	0.930 ± 0.016	118.93**
	arousal	0.969 ± 0.017	122.76**
Brain (I.U. / mg. prot. / hr.)	active	0.228 ± 0.012	---
	Prehibernating	0.196 ± 0.010	85.97**
	hibernating	0.162 ± 0.006	71.05**
	arousal	0.190 ± 0.012	83.33***

Values represent the mean ± S.E. of five animals per group.
*P<0.05; **P<0.01; ***P<0.001 compared to active (control) group by Student's *t*-test.

sharp increase of hepatic 5'-nucleotidase was observed during deep hibernation where a value of 212.86 % of active animals level was recorded which was statistically significant (P<0.001). Arousing animals manifested a small and limited non-significant (P>0.05) increase in hepatic 5´-nucleotidase exhibiting a value of 108.57 % of active animals.

The results indicate that in animals entering into hibernation, the activity of 5'-nucleotidase in kidney declined sharply recording significant (P<0.01) decrease. The value (expressed as a percentage of active animals) was 43.22%. In contrast, with hibernation and arousal from hibernation, 5´-nucleotidase rose significantly (P<0.01) exhibiting values of 118.93% and 122.76% of active animals respectively.

The changes occurring in the 5´-nucleotidase activity in brain of *U. microlepis* showed that animals exhibited significant (P<0.01 and P<0.001) marked declines during the different phases of the hibernating cycle. The values recorded and calculating as a percentage of active were 85.97%, 71.05% and 83.33% in prehibernation, hibernation and arousal respectively.

Discussion

The maintenance of tissues and cellular integrity in hibernating animals especially reptiles during the different phases of the hibernating cycle, with different metabolic profile and under relatively low body temperature raises questions as to the capacity of such tissues to avoid injury. The temperature changes can affect the metabolic pathways (Abdel- Raheem *et al.,* 1989 a, b and c; El Daly *et al.,* 1995 and Abdel-Kader et al., 1995) by the alternation of either enzyme activity or stability and the eventual energy supply to different systems in which processes are energy.

At low temperature there is energy economy in hibernating species, and therefore there is a need to know the impact of such situation on the integrity of the cells.

The study of seasonal variations in nucleic acid levels did not receive the necessary attention in reptiles. This problem is important since several reported works have stressed on the retardation of protein biosynthesis during hibernation which was however restored on arousal (Okasha *et al.,* 1988 and Abdel-Raheem *et al.,* 1989 a and c).

The search for the changes in nucleic acid metabolism in this work revealed increase in DNA content with entrance in hibernation in liver, kidney and brain of *Uromastyx microlepis.* Conversely, when animals were passed to deep hibernation the DNA level declined in all organs studied. Arousal was accompanied by a DNA content lower than that of the active animals. These data obviously demonstrate that the tissues of the major organs liver and kidney maintain an optimum DNA content in *Uromastyx* during hibernating cycle. Similar observations were previously reported on the snake *Eryx colubrinus* and the lizard *Eumeces schneideri* by Abdel-Raheem *et al.* (1989 a) and on the ground squirrel *spermophilus tridecemlineatus* by Squire and Andrews (2003). The maintenance of a minimal DNA content in liver and kidney during the hibernating cycle might be responsible for retardation of protein biosynthesis is such organs. These results run in agreement with the previous studies of Abdel-Raheem *et al.* (1989 c). Also it might be responsible for declining mitotic index of cells. Demonstration of the depression in mitotic index is given in the work of Mayer and Bernick (1958), who recorded seasonal variations in cell replication during hibernation, with a great reduction or even cessation of mitotic activity during bouts, and reappearing in spontaneously arousing animals. Similar observations were as well reported by Unker and Alekseeva (1974); Vinogradova (1982); Abdel-Raheem *et al.* (1989 a) and Squire and Andrews (2003).

Studies performed by Kruman *et al.* (1986) indicated that hibernation induced a decline in DNA synthesis in intestinal crypt cells of ground squirrels. Also Abdel- Raheem et al. (1989 a) reported that decreases in DNA content were observed in different tissues of two reptilian species, *E. colubrinus* and *E. schneideri* during the hibernating season.

In accordance with above observations, the decrease recorded in the present study in DNA content in liver, kidney and brain might reflect the occurrence of decreased rate of biosynthesis and turnover of DNA during the hibernating and arousing seasons in *Uromastyx*. This is clear from observations of Unker and Alekseeva (1974); Vinogradova (1982) and Abdel-Raheem et al. (1989 a).

Analysis of RNA content in liver, kidney and brain of *U. microlepis,* in this work, revealed a profile similar to that found in DNA. The data of RNA show the occurrence of significant increase during prehibernation in different studied tissues. Conversely, when animals were entering in long hibernating period, a significant decrease was noted in RNA content in liver and kidney. The decrease in RNA content regresses by time showing a non-significant decline in liver and kidney of arousing animals. On the other hand, brains did not follow that profile, whereas in hibernating *U.microlepis*, brain RNA increased and was maintained at a high level till arousal. These results agree with previous studies showing an inhibitory effect of hibernation on RNA synthesis in different tissues of *E. colubrinus* and *E. schneideri* except brain (Abdel-Raheem *et al.,* 1989 a). Supporting evidence in favour of the increase of RNA in the brain during hibernation are supplied by O'Hara *et al.* (1999) in ground squirrel *Spermophilus lateralis*. Those authors demonstrated that some mRNA (e.g., c-fos, c-jun) appeared to increase in the brain of ground squirrel during hibernation although these changes do not reach statistical significance until the arousal phase.

However, Frerichs *et al.* (1998); O'Hara *et al.* (1999); Zatsepina *et al.* (2000); Epperson and Martin (2002) and Breukelen and Martin (2002) indicated that no abnormalities in RNA levels during hibernation in tissues of lizard, *Lacerta vivipara* and ground squirrels *Spermophilus tridecemlineatus* and *Spermophilus lateralis*. Frerichs *et al.* (1998) confirmed that no differences between hibernating and active ground squirrel in total mRNA levels in brain and liver. Also, O'Hara *et al.* (1999) found that no evidence for a general decline in total RNA yields, mRNA yields, or specific mRNAs tested in brain during hibernation.

The changes in tissue RNA reported here are closely correlated to the changes encountered with DNA. The level of RNA was reported to be stress dependent (Pevzner, 1981). It was shown that RNA would decrease in oligodendroglia four days after adrenalectomy of rats, a condition which was abolished with daily injection of cortisol. It seems that, it is quite possible that hibernation might induce a decline in pituitary adrenal axis activity, being reflected in a low level of cortisol. In this context, we have previously found that a decline occurs in cortisol in hibernating *Malpolon monspessulanus and Uromastyx aegyptius* (Okasha *et al.,* 1994). Therefore, it might be the case in the animal studied in this work. At the low body temperature achieved during hibernation (8°C or less under our ambient conditions of 5°C), it seemed likely that RNA transcription might virtually cease, and all RNAs would either be maintained or would decrease in abundance. In fact, such a decline might explain the mystery of periodic arousals throughout the hibernation season, which are metabolically costly and limit the energy conservation achieved (Lyman *et al.,* 1982).

However, we cannot extend this interpretation to brains which exhibit RNA levels varying from minor changes to significant increases. In support of our observations ground squirrels exposed to the cooling effect showed a significant accumulation of macromolecules especially RNA in both neurons and perineural oligodendroglia (Pevzner, 1981). Also, Abdel- Raheem *et al.* (1989) recorded that the brains of *E. colubrinus* exhibited a high level of RNA during hibernation. These observations might suggest absence of sensitivity of brain to the low cortisol level claimed to occur during hibernation.

Also, in this report, we found that RNA was clearly higher in the brain than in liver and kidney. These data strengthen the argument that the brain is relatively more active during hibernation than many other tissues. Furthermore, because there does not appear to be a general decline in most mRNAs (which might appear as relative increase in some genes), it is extremely likely that substantial new transcription of some genes does take during arousal from hibernation (as indicated by c-fos induction) and that, in hypothalamus, this may occur even at the coldest body temperature during torper (O'Hara *et al.,* 1999 and Breukelen and Martin, 2002). It does not seem likely that the large increases in immediate early gene mRNAs could occur only by changes in mRNA stability (O'Hara *et al.,* 1999). In addition, our data may be relevant to the fact that animals are increasingly responsive to stimuli as each bout of hibernation progresses (Beckman and Stanton,

1976), suggesting the possibility of increasing central nervous system function and the need for new mRNA synthesis.

The present work examined the possible changes in two enzymes important for nucleic acid metabolism. The first enzyme is the alkaline phosphatase, which has the biological function involved in cellular transport, proliferation and differentiation (Russel *et al.,* 1972 and Karasaki, 1975). The alkaline phosphatase was found to continuously decline in serum, liver and kidneys of *U. microlepis* during hibernation, then recover on arousal. Brains of this animal did not exhibit any appreciable change in the enzyme activity. A similar trend was previously recorded by Okasha *et al.* (1988) and Abdel-Raheem *et al.* (1989 a). Those authors indicated that alkaline phosphatase activity was inhibited during hibernation in serum and different tissues of two reptilian species *E. colubrinus* and *E. schneideri*. Since increased alkaline phosphatase activity is associated with the induction of DNA synthesis and cell replication (Emmelot and Bos, 1969 and 1971), it seems that this enzyme plays the role of maintaining the optimal levels of mononucleotides participating in DNA biosynthesis (Melnykovych *et al.*, 1968 and Melnykovych and Bishop, 1969).

On examination of the DNA profile described above we would be able to identify a close correlation between the DNA profile and the changes recorded for alkaline phosphatase which plays the important role of furnishing the required mononucleotide, in preparation for hibernation followed by a declining activity during deep hibernation. On arousal, the restored activity might account for the DNA content which matches that recorded in the active animal.

The second enzyme studied in this work is 5′-nucleotidase. This is a specific phosphate which acts only on both pyrimidine and purine nucleotides with phosphatase group attached to the fifth carbon of the pentose ring. The analysis of this enzyme in livers of the animals studied in this work, revealed the occurrence of significant sharp increase in the enzyme activity in the deeply hibernating animals, which was followed by a drop in the activity during arousal to a level matching that of active animals. On the other hand, the brains of *U. microlepis* showed a limited but continuous and steady decline in 5′-nucleotidase activities after entering the hibernating phase till arousal phase. However, 5′-nucleotidase level declined in serum of *U. microlepis* during hibernation, then recover on arousal. Kidney 5′-nucleotidase activity in *Uromastyx* increased steadily and significantly from prehibernation till arousal.

The data of 5′- nucleotidase indicate clearly that in livers, perhaps, the enzyme is involved in the preparation of specific nitrogenous bases necessary for nucleic acid synthesis on arousal, which indicates the active role of liver even during hibernation. Brains were shown in animals to keep an optimal levels of DNA & RNA which might explain the declining enzyme activity during hibernation. Kidneys might as well be involved in active preparation for arousal as is shown in the increase in the 5′- nucleotidase activity in hibernation and arousal in *U.microlepis.*

The present data indicate that the resistance of tissues of hibernating *U. microlepis* seems to be a common feature. The decline recorded in the nucleic acids content, in different studied tissues, in this work, might support the claim given in previous studies (Whitten *et al.,* 1970; Otis, 1973; Al-Badry and Al-Sidrawi, 1976; Riedesel and Steffen, 1980; Yacoe, 1983 and Abdel-Raheem *et al.,* 1989 c) that retarded protein biosynthesis might prevail during hibernation. Recovery of the nucleic acid biosynthesis after arousing in *U. microlepis* in the present study would therefore explain the recorded biosynthesis activity of protein especially in liver evidenced by the recovery of normal blood and other tissues protein on arousal (Abdel-Raheem *et al.,* 1989 a and c). It is interesting that in hibernation, with availability of limited amounts of energy the cells can maintain its integrity (Abdel-Raheem *et al.,* 1988 a, b and c). It appears that enzymes controlling the permeability changes especially ATP-ase system may maintain its function during hibernation and are capable of utilizing a lower energy of activation (Abdel-Raheem *et al.,* 1989 b and Abdel-Kader *et al.,* 1995) than do similar enzymes in non-hibernators (South and House, 1969).

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التغيرات في أيض الأحماض النووية في الضب في الدخول أثناء والصحيان من البيات الشتوي

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الملخص: تم إجراء هذه الدراسة لمعرفة التغيرات التي تحدث في نمط الأحماض النووية في الأنسجة المختلفة في السحلية ذات الأشواك على الذيل التي تعرف بالضب . كما تم دراسة التغيرات التي تحدث في كل من إنزيمي الفوسفاتيز القاعدي و5`- نيكليوتيديز في السيرم والأنسجة المختلفة للضب أثناء المراحل المختلفة للبيات الشتوي . كشفت النتائج عن وجود ارتفاع مبدئي في محتوى **DNA** في الأنسجة المختلفة أثناء الإعداد للبيات الشتوي متبعاً بنقص أثناء البيات الشتوي . والنقص الحادث في **DNA** ربما يرجع إلى نقص في تكون الحامض النووى (**DNA**) في الانسجه المختلفة أثناء فصل الشتاء. أظهرت نتائج تحليل **RNA** أن البيات الشتوي يسبب نقص في محتواه في الكبد والكلى في الضب أوعلى العكس من ذلك فلم يتبع المخ هذا النمط حيث حدث زيادة في محتوى **RNA** فيه أثناء البيات الشتوي ظلت حتى الصحيان من البيات. بينت النتائج أنه حدث نقص في نشاط إنزيم الفوسفاتيز القاعدي أثناء البيات الشتوي في السيرم والأنسجة المختلفة للضب وهذا النقص يعود إلى المستوى الطبيعي في الصحيان من البيات. ولقد كشفت النتائج عن وجود علاقة مرتبطة بين نمط التغيير في **DNA** و إنزيم الفوسفاتيز القاعدي وهذا يعني أن إنزيم الفوسفاتيز القاعدي له دور في تكوين النيكليوتيدات في المراحل المختلفة للبيات الشتوي. كما أظهرت النتائج حدوث نقص مبدئي فى نشاط إنزيم -5` نيكليوتيديز في الكبد والكلى أثناء الإعداد للبيات الشتوي متبعا بزيادة أثناء البيات الشتوي ونقص أثناء الصحيان من البيات وخصوصا في الكبد وعلى الجانب الأخر فان إنزيم 5`- نيكليوتيديز اظهر نقص في كل من السيرم والمخ أثناء مراحل البيات الشتوي المختلفة بينما يقترب هذا النقص إلى المستوى الطبيعي للحيوانات النشطة أثناء الصحيان من البيات الشتوي . كشفت النتائج أن الأحماض النووية لابد أن تظل موجودة عند تركيزات مثلى أثناء مراحل البيات الشتوي حيث أنها تقوم بدورها في التحكم في ايض البروتين .