Vet.Med.J.,Giza. Vol.57, No.1. (2009):77-95

VARIABILITY OF SERUM BIOCHEMISTRY IN WILD CATFISH CLARIAS GARIEPINUS COLLECTED FROM SOUTH AND NORTH CAIRO AREA. I. LIVER AND KIDNEY FUNCTIONS.

Esam H. Rizkalla; * Basem A.G. Fahmy *and Ferial M.N. Fudllalah**

Biochemistry, Nutritional Deficiency Diseases and Toxicology

Dept., Animal Health Res. Inst., Agri. Res. Cen., Dokki, Giza, Egypt.Zoology Dept of., Faculty. of Sci., Zagazig Uni.

Key words: Clarias gariepinus, Serum gamma glutamyl transferase, Serum alkaline phosphatase, Serum urea, Serum uric acid, Serum creatinine, Season, Location, Sex.

Recived 20/05/ 2009.

Accepted 15/06/2009.

SUMMARY

Fish serum reflects status of many biochemical processes in the metabolism. Many environmental stressors alter serum biochemical parameters in fishes. Thus, both sexes of Nile catfish, *Clarias gariepinus*, were collected from south (Al-Aiat) and north (Barrage) Cairo city to investigate the responses of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), urea, uric acid and creatinine to environment in different seasons. Different seasonal patterns were reflected for serum biochemical parameters in all fish groups studied. Season significantly affected the serum ALP in all groups. Male's serum urea and uric acid from the two regions showed significant seasonal changes in addition to the female's serum urea from Barrage region. For serum creatinine, only females from Al-Aiat region demonstrated significant seasonal changes. Serum γ-GT did not show any significant seasonal change in this study.Location effect appeared more evident with serum ALP and urea and to lesser degree with serum creatinine. Serum γ-GT and uric acid were the lowest parameters affected with the location of samples.

Serum γ-GT, ALP, urea and uric acid were affected by fish sex, while serum creatinine showed no significant sex change.All the serum biochemical parameters were affected by the interactions of season with location and season with both location and sex, while the interaction of location with sex affected only serum ALP and creatinine. No change was detected for the effect of season interaction with sex on the serum parameters.

INTRODUCTION

In human and veterinary medicine, the relationship between diagnosed tissue lesions and serum constituents (metabolic, enzymes, etc.) changes has led to the use of selected serum tests to ascertain and confirm specific tissue dysfunction and/or damage. Also, biochemical parameters are used as health indicators in aquatic medicine following different stress conditions (Thrall, 2004; Pimpão et al., 2007). Biochemical analytes in fish have been documented to be affected by capture and sample collection technique (McDonald and Milligan, 1992), environmental factors, culture conditions, and age and sex of the fish (Warner and Williams, 1977; Bhaskar and Rao, 1989; Bucher, 1990). Biochemical analytes also have been used to assess physiologic effects of toxicants and diseases (Michael et al., 1987; Bhaskar and Rao, 1989; Bucher, 1990).Clinical reference ranges of variation have been determined for selected biochemical analytes in a number of species, including rainbow trout (Wedemeyer and Nelson, 1975), striped bass (Tisa and Strange, 1983), milkfish (Bhaskar and Rao, 1989), and channel catfish (Warner and Williams, 1977). The siluroid air-breathing catfish (Clarias gariepinus) is an edible fish and represents a species with a wide range in ponds, lakes and River Nile and having a commercial and ecological value. This species is a top predator in aquatic ecosystems and it generally represents a stationary species. It possesses four pairs of barbles which are sensitive to pH, salinity and temperature of the medium. All these figures, as well as the fact that many experiments were conducted on this species, both in laboratory conditions (Rizkalla, 1988; Nounou et al., 1997; Nabih et al., 2003; Rizkalla et al., 2003a) and in natural populations (Rizkalla, 1983; Soliman et al., 1991, 1998; Rizkalla et al., 1999, 2003b). Moreover Clarias species is known to be more tolerant to pollutants (El-Shehawi et al., 2007), make it very suitable for pollution monitoring in aquatic ecosystems. Thus there is a need to examine more critically the association between serum parameters and possible tissue dysfunction and/or damage in C. gariepinus potentially exposed to contaminants in the urban and non-urban environment. The aim of this paper was to describe the results of annual environmental investigations for characterizing two sections of the River Nile using adult catfish C. gariepinus of wild origin as the test species and to determine the importance of the biochemical parameters of the blood sera as indicators of the population condition at two localities under different types of environmental stress.

MATERIAL AND METHODS

Field collection:

The collection of samples was performed by commercial fishermen who fished the catfish Clarias gariepinus systematically. The positions of the two sampling sites are shown on the map (Fig. 1). The study was conducted on the River Nile around Cairo area, extending roughly 100 km from Al-Aiat (south) to Barrage (north). Fishing trips to the studied areas were carried out every three months over a period of one year. The number of fish collected each season and the average total body length (cm) from both fishing sites are outlined in Table 1.

Fig. (1): The location of the two sites studied on the River Nile.

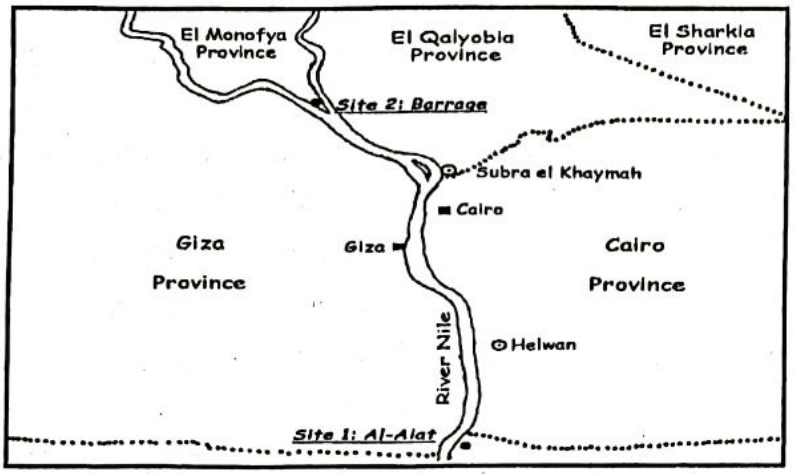


Table (1): Mean ± Standard deviation of the total body length (cm) of Clarias gariepinus collected from Barrage and Al-Aiat regions.

	Winter season January 2008		Spring season April 2008		Summer season July 2008		Autumn season October 2008	
	Male	Female	Male	Female	Male	Female	Male	Female
Barrage region:								
No. of samples	8	10	8	8	8	8	12	7
Range	31 – 37	29 – 34	34 – 40	31 – 42	27 – 34	30 – 37	27 – 40	28 – 39
Mean	34.3	31.3	36.8	35.9	31.1	32.8	32.8	31.6
S.D. ±	2.435	1.567	2.188	3.300	2.295	2.816	4.366	3.780
Al-Aiat region:								
No. of samples	10	8	8	8	11	7	11	11
Range	25 – 40	25 – 37	31 – 41	29 – 39	25 – 36	28 – 33	26 – 37	22 – 38
Mean	34.9	34.5	34.7	36.3	32.4	31.1	31.4	30.9
S.D. ±	5.174	4.000	3.348	3.059	3.355	1.676	3.749	4.721

All fish were hauled and transferred directly into clean holding tanks to avoid the possibility of contamination and kept aboard the research vessel until blood sampling could be carried out within 24 hours in the Animal Health Research Institute.

Analysis:

Blood was collected, after heart puncture, in sterile tubes, allowed for clotting overnight at 4° C and the serum was removed and stored at -20° C until analyses could be performed. Serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), urea, uric acid and creatinine concentrations were measured using the techniques described by the Bio-Diagnostic Kits, Egypt.

Statistical analyses:

Comparisons of means were performed with *t*-tests (Snedecor, 1971). For the smaller subset of data on the biochemical variables and compartmentation studies, a simple ANOVA was used to compare seasonal variability only. An analysis of variance (ANOVA) was used with the factors season, location and sex interactions (Farver, 1989). The analysis was preformed using SPSS for windows release 8.0.0, standard versions (SAS Version 8.2, Proc Mixed, SAS Institute, Cary, NC),

RESULTS

Data of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), urea, uric acid and creatinine of both male and female *Clarias gariepinus* collected from Barrage and Al-Aiat regions are tabulated in tables (2 – 5) for winter, spring, summer and autumn seasons respectively.

I. Effect of season:

Figures (2 – 6) represents the seasonal changes of the studied serum parameters:

Serum gamma glutamyl transferase (γ-GT) of males and females *C. gariepinus* collected from Barrage and Al-Aiat regions demonstrated different seasonal changes (Fig. 2). Both males and females from Barrage area showed increased values from winter season up to spring (9.004 ± 4.806 U l^{-1} for males) and summer (15.317 ± 6.200 U l^{-1} for females) then decreased to the lowest values at autumn season (5.975 ± 4.539 and 6.618 ± 4.432 U l^{-1} respectively). On the contrary, both males and females from Al-Aiat area showed decreasing values from winter season (14.258 ± 8.214 and 15.036 ± 7.387 U l^{-1} respectively) till spring (7.651 ± 3.557 U l^{-1} for males) and summer (7.046 ± 4.453 U l^{-1} for females).Serum alkaline phosphatase (ALP) for both males and females fish collected from both regions (Fig. 3) showed highest values at winter season (table 2) and lowest values at autumn season (table 5). ALP, at summer season (table 4), for both sexes and regions showed raised values and this is more obvious in Al-Aiat area (7.795 ± 1.358 IU l^{-1} for females and 7.672 ± 0.951 IU l^{-1} for males). According to the location of samples, serum urea of both males and females fish showed zigzag lines (Fig. 4) in different seasons. Fishes from Barrage area recorded highest values at summer season (35.631 ± 11.223 mg/dl for females and 34.400 ± 8.442 mg/dl ml for males) and lowest values at spring for males (20.666 ± 9.363 mg/dl) and autumn for females (14.609 ± 5.772 mg/dl). Oppositely, fishes from Al-Aiat area recorded highest values at spring season (35.673 ± 10.424 and 33.328 ± 15.295 mg/dl for males and females respectively) and lowest values at summer (13.598 ± 6.265 and 20.516 ± 6.603 mg/dl for males and females respectively).

Serum uric acid (Fig. 5) of all fishes recorded highest values at winter season (table 2) except females from Al-Aiat area at spring season (8.968 ± 1.973 mg/dl). The lowest values were recorded at summer season for both sexes form Barrage area (table 4) and at autumn season for both sexes from Al-Aiat area (table 5).

Seasonal changes in serum creatinine (Fig. 6) showed different patterns. Fish collected from Barrage area, the male ones recorded highest value at winter season (1.827 ± 0.113 mg/dl) then decreased steadily to reach 1.344 ± 0.481 mg/dl at autumn, while the female ones recorded high values at winter, summer and autumn seasons (1.818 ± 0.138, 1.819 ± 0.209 and 1.789 ± 0.816 mg/dl respectively) and the lowest value was at spring (1.462 ± 0.320 mg/dl). Fish collected from Al-Aiat area, males and females recorded low values at winter season (1.185 ± 0.456 and 0.948 ± 0.370 mg/dl respectively). The male ones increased steadily to reach 1.724 ± 0.052 mg/dl at autumn, while the female ones increased to the high values at summer and autumn seasons (1.742 ± 0.289 and 1.741 ± 0.063 mg/dl respectively).Table (6) demonstrated the effect of season on the studied serum biochemical parameters of both sexes of C. gariepinus collected from Barrage and Al-Aiat regions. Season significantly affected on the serum ALP in all fish groups studied. Serum urea and uric acid of males from the two regions studied showed significant seasonal changes in addition to the females from Barrage region for serum urea ($P < 0.05$). In case of serum creatinine, only females from Al-Aiat region demonstrated significant seasonal changes ($P < 0.01$). Serum γ-GT did not show any significant seasonal change throughout this study.

II. Effect of location:

Serum γ-GT showed significant higher and lower values in females from Al-Aiat area than that from Barrage area at winter ($P < 0.01$) and summer ($P < 0.05$) seasons respectively (tables 2 & 4), while no significant values for males.

Male and female fishes from Al-Aiat area recorded significant lower serum ALP values than that from Barrage area at the four seasons studied for males (table 2 - 5), and at both winter and autumn for females (tables 2 & 5). At winter and summer seasons (tables 2 & 4), serum urea of females from Al-Aiat area showed significant ($P < 0.01$) lower values than that from Barrage area. Also males from Al-Aiat recorded significant ($P < 0.001$) lower value than that of Barrage at summer (table 4). On the other hand, at spring and autumn seasons (tables 3 & 5) serum urea values were significantly higher in male fish from Al - Aiat ($P < 0.01$, at spring) and in both males and females ($P < 0.001$, at autumn) than that from Barrage.Only significant serum uric acid values were detected at summer season (table 4). They showed higher values in fishes from Al-Aiat than that from Barrage ($P < 0.001$ for male and $P < 0.01$ for female).Male and female fishes from Al-Aiat area recorded significant lower creatinine values at winter season (table 2) than that from Barrage ($P < 0.01$ for male and $P < 0.001$ for female), while at autumn (table 5) male fish from Al-Aiat showed significant ($P < 0.05$) higher value.

III. Effect of sex:

Significant ($P < 0.05$) higher serum γ-GT and uric acid values were found in the females collected from Barrage area than that of males at summer (table 4) and spring (table 3) seasons respectively, while serum ALP value was significantly ($P < 0.05$) lower in female fish from Al-Aiat area than that of males at winter season (table 2). Serum urea values were significantly ($P < 0.05$) lower in female fish from Barrage area at autumn season (table 5) and higher in female fish from Al-Aiat area at summer (table 4) than that of males of the same location.Using multiple ANOVA test, table (7) demonstrates the interactions of the three factors (season of sampling, location of samples and sex of fish) on the biochemical parameters tabulated in tables 2 – 5. The five serum biochemical items studied showed significant results in both (season X location) and (season X location X sex) interactions. The interaction (location X sex) recorded significant cases for serum ALP and creatinine, while (season X sex) interaction did not show any significant cases.

DISCUSSION

Pollution of the aquatic environment by agricultural and industrial chemicals, spilled oil, mine effluents and many other chemical contaminants has been recognized for years (Mehrle and Mayer, 1985). The major economically important non-target species that are very much affected by the aquatic pollution are fish. In the wild, sublethal levels of pollutants may impair fish behaviour, growth, maturation, reproduction and other functions that may have important population consequences without causing lethality (CCHWC,

1993) as well as increasing susceptibility to disease and decreased immune responsiveness (Ellis, 1988).

Enzymes are biochemical macromolecules that control metabolic processes of organisms, thus a slight variation in enzyme activities would affect the organism (Roy, 2002). In the present study, no significant data were recorded in serum gamma-glutamyl transferase (γ-GT) of both sexes of Clarias gariepinus among the four seasons from both Barrage and El-Aiat areas (tables 2 – 5; Fig. 2). Concerning location effect on γ-GT only female fish from El-Aiat in both winter and summer seasons had higher values than that from Barrage (tables 2 and 4). For sex effect, female fish from Barrage had significant higher value than males in summer season (table 4). Season did not show any significant effect on serum γ-GT (table 6), but the interaction of season with location on one hand and with both location and sex on the other hand showed significant results (table 7). Recently, γ-GT has been used as pathological and toxicological indicator in clinical examination and toxicity research in parallel with plasma aminotransferase activities when a fish receives an external shock. The unique references collected in this respect were carried on the oral toxicity of microcystin (a cyclic peptide hepatotoxin produced from Microcystis bloom that occurs frequently in the bodies of freshwater) on common carp (Cyprinus carpio) and goldfish (Carassius auratus). Fischer and Dietrich (2000) and Malbrouck et al. (2003) reported that microcystin has been correlated with the activity of certain plasma enzymes, such as γ-GT, alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP), while Li et al. (2004) indicated that ALT and AST activities were significantly increased in serum of common carp fed on Microcystis bloom, but γ-GT activity remained unchanged. In contrast to γ-GT, serum ALP activities in the present study tended to decrease from winter to autumn in both sexes from Barrage area and males from Al-Aiat area. Females from Al-Aiat area increased firstly from winter to summer then dropped nearly the value of its male in autumn season (tables 2-5, Fig. 3). Clear seasonal significant values were calculated by ANOVA test for both sexes collected from both areas (table 6). Comparison between sexes proved no significant values except female fish from Al-Aiat area at winter season had lower ALP value than that of its male (table 2). The multiple ANOVA test showed significant interactions between season X location; location X sex; and season X location X sex (table 7). Fishes collected from Barrage area were in accordance with the results of Shalabi et al. (2000) and Rizkalla et al. (2003a) on the same fish. They recorded that the normal ALP in the summer season ranged 8.2 ± 0.749 – 10.0 ± 1.064 U l-1 and 9.58 ± 0.77 – 9.64 ± 0.74 U l-1 respectively. Gaber and Abd-Allah (2003) recorded higher values (15.3 ± 0.88 – 15.8 ± 0.58 U l-1) for C. gariepinus. Shalabi et al. (2000); Rizkalla et al. (2003a) and Gaber and Abd-Allah (2003) reported that the serum ALP activity significantly raised after exposure to $CuSO_4$ (2.5 mg Cu/l for 10 days); antibiotics (ciprofloxacin, amoxicillin and ampicillin 15, 50 and 80 mg/kg body weight respectively) and Pseudomonas fluorescens respectively.Alkaline phosphatase is a polyfunctional enzyme located primarily in the cell membrane, which hydrolyses a broad class of phosphomonoester substrates and acts as a transphosphorylase at alkaline pH. It also plays a pivotal role in the mineralization of the skeleton of aquatic animals (Zikic et al., 2001).

ALP activity appears to be highly variable in fish. It may be affected by a wide range of factors both methodological and individual (Roscoe Miller et al., 1983; Hrubec and Smith, 1999). Plasma ALP activity is influenced by many factors, including water chemistry (Bowser et al., 1989), temperature (Sandnes et al., 1988), feed intake (Sauer and Haider, 1979), and life stage (Johnston et al., 1994). Roscoe Miller et al. (1983) and Folmar et al. (1992) reported no relationship between ALP and body temperature of rainbow trout and striped mullet. Enhanced serum ALP activity had been shown in air-breathing climbing perch Anabas testudineus (Peter et al., 2007); monosex tilapia Oreochromis niloticus (El-Sayed et al., 2007 and El-Sayed and Saad, 2008) and silver catfish Rhamdia quelen (Borges et al., 2007) exposed to a number of pesticides. Moreover, metal exposure raised serum ALP activity as in tambaqui (DeOliveira et al., 2004) and Oreochromis niloticus (Atli and Canli, 2007). The above authors may explain the obvious observation in this study which recorded higher ALP activities in both sexes of Clarias gariepinus collected from Barrage area than that recorded in fishes from Al-Aiat area at the four seasons (Fig. 3). The significant values recorded between them were at both winter and autumn seasons for both sexes (tables 2, 5) and only males at both spring and summer seasons (tables 3, 4). On the contrary, Bernet et al. (2001) and Öner et al. (2008) presented a drop of serum ALP activity in metal-exposed Salmo trutta and Oreochromis niloticus. Bernet et al. (2001) indicated that the decrease in ALP activity might be a result of a disturbance of the membrane transport system, although the increase in the activity may be related to tissue damage.

Generally, it has been shown that the liver is the prime location for removing xenobiotics and biocides in fishes (Roy, 2002). The change in the activities of AST, ALT and ALP, indicate disturbance in the structure and integrity of cell organelles, like endoplasmic reticulum and membrane transport system (Roy, 2002; Humtsoe et al., 2007). Thus, the leakage of these enzymes to the blood stream corresponding to the stress condition of the treated animals and their measurement in the circulating fluid is frequently used as a diagnostic tool and sensitive biomarkers in ecotoxicology (Vaglio and Landriscina, 1999; Levesque et al., 2002; Palanivelu et al., 2005).Both sexes of Clarias gariepinus collected from Barrage and Al-Aiat areas showed seasonal changes in serum urea values in a zigzag manner oppositely different according to the site of sampling (tables 2 – 5, Fig. 4). For serum uric acid, values decreased from winter to autumn in both sexes and areas studied (tables 2 – 5, Fig. 5) whereas from Barrage area summer values were the lowest for both sexes (table 4). For serum creatinine, both sexes from Al-Aiat area showed increased values from winter to autumn, while males from Barrage area decreased during the same period. Females from Barrage area nearly did not change between the same seasons with lowest value at spring season (tables 2 – 5, Fig. 6). Using multiple ANOVA test, significant interactions between season and location in one hand and season X location X sex on the other hand were calculated for both serum urea and uric acid. For serum creatinine, a third interaction between location and sex was recorded (table 7). Present results of serum urea and uric acid were in accordance with Rizkalla et al. (2003a) while serum creatinine appeared lower. The serum creatinine of the present study was in the same range of that recorded by Shalabi et al. (2000) in control C. gariepinus. Abd El-Alim et al. (1998) recorded higher values of serum urea and creatinine, while lower values of serum urea and uric acid (Shalabi et al., 2000) and serum uric acid and creatinine (Gaber and Abd-Allah, 2003) were mentioned. Working on Indian Catfish C. batrachus, Joshi and Bose (2002) recorded the same values of serum urea and lower values of serum creatinine. Abd El-Alim et al. (1998) and Rizkalla et al. (2003a) said that the three serum items studied are significantly increased by antibiotics treatment, while infection with Pseudomonas fluorescens insignificantly reduced serum uric acid and creatinine (Gaber and Abd-Allah, 2003). Shalabi et al. (2000) and Joshi and Bose (2002) said that exposure of fish to CuSO4 (for 6 days) and CdCl2 (for 30 days) respectively significantly raised serum urea, uric acid and creatinine.Ammonia is a toxic nitrogenous end product released exogenously and endogenously (Mommsen and Walsh, 1992). Urea nitrogen is a non-toxic compound was used to partly detoxify total ammonia nitrogen loaded in the body (Mommsen and Walsh, 1991; Wood, 1993; David et al., 2004). Uric acid is an alternative nitrogen product not excreted in detectable quantity and creatinine is another nitrogenous waste product but contributed only a small fraction to total nitrogen excretion (Kajimura et al., 2004). Urea is mostly synthesized in fish livers (Wood, 1993; Walsh and Mommsen, 2001). Uricolysis through degradation of purines seems to be the most important metabolic pathway for urea production in ammonotelic fishes and appear to be present in most species. Syntheses through uric acid or arginine degradation (Campbell, 1991) are two other less important pathways for urea production (Wilkie, 2002). In fish, gills and kidney are interdependent coordinated system for nitrogen excretion (Wood, 1993; Singer, 2003). Ammonotelic teleosts had branchial urea transporters through which relatively small amounts of urea excreted (Wood, 1993; Walsh and Smith, 2001) a way of detoxify ammonia in some species (Evans et al., 2005). Elevated plasma levels of urea and creatinine in throughout different fish species might appear due to pollution (Everall et al., 1991); pesticides (Peter et al., 2007) and Ag-, Cd- and Cu-exposure (Öner et al., 2008). Serum urea levels generally were enhanced by metal treatment (Yang and Chen, 2003; McDonald and Grosell, 2006).The significant seasonal effect on serum urea concentrations in both sexes of Clarias gariepinus collected from barrage area and in males only collected from Al-Aiat area; on serum uric acid content in males only collected from the two areas studied; and on serum creatinine value in females collected from Al-Aiat area (table 6) were emphasized by the work of Folmar et al. (1992). They found significant changes in the blood urea and uric acid levels of striped mullet during a year of study while creatinine did not vary significantly and attributed these significant fluctuations to the sexual maturation. Also, Lockhart and Metner (1984) mentioned that the differences in the concentration of creatinine in certain periods of the year could be related to differences in spawning activities and/or the consequence of a kidney dysfunction. With regard to site and seasonal variation, Hopkins et al. (1997) referred that plasma urea and hepatic glutamine synthetase (GNS) activities, a central enzyme of ureogenesis in toadfish (Mommsen and Walsh, 1991), varied both between sites and seasons. Interestingly, they also observed that plasma urea and liver GNS were not significantly correlated with any abiotic variables (e.g. temperature, salinity, dissolved oxygen and depth) and no indication of increased ureotely in male toadfish during the breeding season. In the present work, the sexually significant differences in serum urea values were recorded at both summer (for Al-Aiat, table 4) and autumn (for Barrage, table 5) seasons. The females from Barrage area had significant higher uric acid value than males at spring season (table 3). No influence of sex on serum urea nitrogen was detected by Casillas et al. (1985).According to locality, both sexes from Al-Aiat area had significant lower and higher serum urea values than that from Barrage area at summer (table 4) and autumn (table 5) seasons respectively and at winter (female only, table 2) and spring (male only, table 3) seasons respectively. Both sexes from Al-Aiat area had higher uric acid values (table 4) and lower creatinine values (table 2) than that from Barrage area at summer and winter seasons respectively. Also, male fish from Al-Aiat area had higher serum creatinine value than that from Barrage area at autumn season (table 5). Higher plasma urea concentrations have been measured for teleosts (e.g. the Lahontan cutthroat trout of Pyramid Lake, a cyprinid of Lake Van, Turkey, and a tilapia of Lake Magadi, Kenya) living in unfavorable environments for ammonia excretion (waters with a pH between 9.4 and 10.0) that inhibited passive ammonia excretion via diffusion trapping and appeared to elevate urea synthesis partially (Lahontan cutthroat trout and cyprinid), or completely (Lake Magadi tilapia) to compensate for reduced ammonia excretion (Randall et al., 1989; Wood, 1993). Dosdat et al. (1996) said that marine fish (eg. sea bass, sea bream and turbot) had an average urea-N plasma concentration 7-8 times higher than that of freshwater fish (rainbow trout and brown trout).Finally, blood urea nitrogen can be used as a sensitive tool to predict the gill and kidney dysfunction in fish (Lockhart and Metner, 1984; Stoskopf, 1993). Under normal culture conditions, Knoph and Masoval (1996) found that plasma urea level was highly variable in individual Atlantic salmon and may be difficult to use as diagnostic tools. This seems to be a proper assessment as individual fish within the same treatment may ingest variable quantities of feed and thus have quite different intermediary metabolism occurring which might be controlled if the fish had been forced-fed a known quantity of diet. Whereas creatinine value is unaffected by protein intake and according to Lall et al. (1997) rise in creatinine value is an indication of renal tubular damage. The level of serum uric acid biosynthesis is an important indicator of the amino acid demand and biological value of feed (Koudela, 1983).

Conclusion:

Although laboratory experiments can provide insight into the causes of blood chemistry variability, extrapolation of findings to free-living animals may be subject to error because of differences between field and laboratory conditions or between free-living and laboratory-reared fish. Field-sampled fish generally show greater variability and wider range of values of blood parameters in comparison with the laboratory-reared fish (Edsall, 1999). Therefore, the physiological significance of changes in blood chemistry can, however, be uncertain and complex because some blood chemistry variables are responsive to multiple endogenous and exogenous influences. One of the questions posed in this study was whether a field assessment of serum parameters could be used to evaluate the health of catfish Clarias gariepinus in areas of chemical contamination. The significant changes in evaluate the health of catfish Clarias gariepinus in areas of chemical contamination. The significant changes in serum chemistry values of C. gariepinus in Al-Aiat and Barrage regions were reasonable considering the diverse nature and the concentrations of xenobiotics identified in those urban environments. However, those findings were not entirely consistent may be related, in part, to the small sample sizes or to the marked difference between the chemical compositions of sediments represented in the different urban environments

REFERENCES

Abd El-Alim, A.F.; Abu El-Magd, M.M. and El-Atabany, A. (1998): Fluoroquinolone residue in catfish. Zagazig J. Pharm. Sci., 7 (1): 101-104.

Atli, G. and Canli, M. (2007): Enzymatic responses to metal exposures in a freshwater fish Oreochromis niloticus. Comp. Biochem. Physiol., 145 C: 282-287.

Bernet, D.; Schmidt, H.; Wahli, T. and Burkhardt-Holm, P. (2001): Effluent from a sewage treatment works causes changes in serum chemistry of brown trout (Salmo trutta L.). Ecotoxicol. Environ. Saf., 48: 140-147.

Bhaskar, B.R. and Rao, K.S. (1989): Influence of environmental variables on hematology, and compendium of normal hematological ranges of milkfish, Chanos chanos (Forskal) in brackish culture. Aquaculture, 83: 123-136.

Borges, A.; Scotti, L.V.; Siqueira, D.R.; zanini, R.; do Amaral, F.; Jurinitz, D.F. and Wassermann, G.F. (2007): Changes in hematological and serum biochemical values in jundiá Rhamdia quelen due to sub-lethal toxicity of cypermethrin. Chemosphere, 69: 920-926.

Bowser, P.R.; Wooster, G.A.; Aluisio, A.L. and Blue, J.T. (1989): Plasma chemistries of nitrite stressed Atlantic salmon Salmo salar. J. World Aquacult. Soc., 20: 173-180.

Bucher, F. (1990): Organ patterns and natural fluctuations of blood enzymes of rainbow trout (Salmo gairdneri Rich.). Comp. Biochem. Physiol., 96B: 795-799.

Campbell, J.W. (1991): Excretory nitrogen metabolism. In "Environmental and Metabolic Animal Physiology". C.L. Prosser (ed.), pp. 277-324, NY, Wiley-Liss.

Canadian Cooperative Wildlife Health Centre "CCHWC" (1993): "Wildlife disease Investigation Manual". University of Saskatchewan, Sakatoon, SK.

Casillas, E.; Myers, M.S.; Rhodes, L.D. and McCain, B.B. (1985): Serum chemistry of diseased English sole, Parophrys vetulus Girard, from polluted areas of Puget Sound, Washington. J. Fish Dis., 8 (5): 437-449.

David, M.; Mushigeri, S.B.; Shivakumar, R. and Philip, G.H. (2004): Response of Cyprinus carpio (Linn) to sublethal concentration of cypermethrin: alterations in protein metabolic profiles. Chemosphere, 56: 347-352.

DeOliveira, C.P.F.; Menezes, A.C.L. and Val, A.L. (2004): Effects of copper and lead on tambaqui, Colossoma macropomum (Cuvier, 1818). VIth Symposium of "International Congress on the Biology of Fish". Manaus (Brazil) 1-5 August 2004, pp. 25-30.

Dosdat, A.; Servais, F.; Métailler, R.; Huelvan, C. and Desbruyères, E. (1996): Comparison of nitrogenous losses in five teleost fish species. Aquaculture, 141: 107-127.

Edsall, C.C. (1999): A blood chemistry profile for lake trout. J. Aquat. Anim. Health, 11: 81-86.

Ellis, A.E. (1988): Optimising factors for fish vaccination. In: "Fish Vaccination". Acad. Press: London, UK, p. 35.

El-Sayed, Y.S. and Saad, T.T. (2008): Subacute intoxication of a deltamethrin-based preparation (Butox® 5% EC) in monosex Nile tilapia, Oreochromis niloticus L. Basic & Clin. Pharmacol. & Toxicol., 102 (3): 293-299.

El-Sayed, Y.S.; Saad, T.T. and El-Bahr, S.M. (2007): Acute intoxication of deltamethrin in monosex Nile tilapia, Oreochromis niloticus with special reference to the clinical, biochemical and haematological effects. Environ. Toxicol. Pharmacol., 24: 212-217.

El-Shehawi, A.M.; Ali, F.K. and Seehy, M.A. (2007): Estimation of water pollution by genetic biomarkers in tilapia and catfish species shows species-site interaction. African J. Biotechnol., 6 (7): 840-846.

Evans, D.H.; Piermarini, P.M. and Choe, K.P. (2005): The multifunctional fish gill: Dominant site of gas exchange, osmoregulation, acid-base regulation, and excretion of nitrogenous waste. Physiol. Rev., 85: 97-177.

Everall, N.C.; Mitchell, C.G.; Groman, D.B. and Johnston, J.A.A. (1991): Tracing of haematotoxic agents in water with the aid of captive fish: a study with captive adult Atlantic salmon Salmo salar in the river Don, Aberdeenshire, Scotland. Dos. Aquat. Org., 10: 75-85.

Farver, B.T., (1989): Concepts of normality in clinical biochemistry. In "Clinical Biochemistry of Domestic Animals", Kaneko, ed. P2-18 Academic Press, NY.

Fischer, W.J. and Dietrich, D.R. (2000): Pathological and biochemical characterization of microcystin-induced hepatopancreas and kidney damage in carp (Cyprinus carpio). Toxicol. Appl. Pharmacol., 164: 73-81.

Folmar, L.C.; Moody, T.; Bonomelli, S. and Gibson, J. (1992): Annual cycle of blood chemistry parameters in striped mullet (Mugil cephalus L.) and pinfish (Lagodon rhomboids L.) from the Gulf of Mexico. J. Fish Biol., 41 (6): 999-1011.

Gaber, F.E. and Abd-allah, A.A.M. (2003): Biochemical studies on the effect of ofloxacin in catfish (Clarias gariepinus). Egypt. J. Agric. Res., 81 (2): 865-877.

Hopkins, T.E.; Serafy, J.E. and Walsh, P.J. (1997): Field studies on the ureogenic gulf toadfish, in a subtropical bay. II. Nitrogen excretion physiology. J. Fish Biol., 50: 1271-1284.

Hrubec, T.C. and Smith, S.A. (1999): Difference between plasma and serum samples for the evaluation of blood chemistry values in rainbow trout, channel catfish, hybrid tilapias, and hybrid striped bass. J. Aquat. Anim. Health, 11: 116-122.

Humtsoe, N.; Davoodi, R.; Kulkarni, B.G. and Chavan, B. (2007): Effect of arsenic on the enzymes of the rohu carp, Labeo rohita (Hamilton, 1822). Raffles Bull. Zool., 14: 17-19.

Johnston, C.E.; Horney, B.S.; Deluca, S.; MacKenzie, A.; Eales, J.G. and Angus, R. (1994): Changes in alkaline phosphatase isoenzyme activity in tissues and plasma of Atlantic salmon (Salmo salar) before and during smoltification and gonadal maturation. Fish Physiol. Biochem., 12: 485-497.

Joshi, P.K. and Bose, M. (2002): Toxicity of cadmium: a comparative study in the air breathing fish, Clarias batrachus and in non-air breathing one, Ctenopharyngodon idellus. Vth Symposium of "International Congress on the Biology of Fish". Vancouver (Canada) 21-26 July 2002, pp. 109-118.

Kajimura, M.; Croke, S.J.; Glover, C.N. and Wood, C.M. (2004): Dogmas and controversies in the handling of nitrogenous wastes: The effect of feeding and fasting on the excretion of ammonia, urea and other nitrogenous waste products in rainbow trout. J. Exp. Biol., 207: 1993-2002.

Knoph, M.B. and Masoval, K. (1996): Plasma ammonia and urea levels in Atlantic salmon in sea water. J. Fish Biol., 49: 165-168.

Koudela, K. (1983): Dynamics of the Uiricotelism in the Domestic Fowl. Videopress MON, p. 223.

Lall, S.B.; Das, N.; Rama, R.; Peshin, S.S.; Khatter, S.; Gulati, K. and Seth, S.D. (1997): Cadmium induced nephrotoxicity in rats. Indian J. Exp. Biol., 35: 151-154.

Levesque, H.M.; Moon, T.W.; Campbell, P.G.C. and Hontela, A. (2002): Seasonal variation in carbohydrate and lipid metabolism of yellow perch (Perca flavescens) chronically exposed to metals in the field. Aquat. Toxicol., 60: 257-267.

Li, X.Y.; Chung, I.K.; Kim, J.I. and Lee, J.A. (2004): Subchronic oral toxicity of microcystin in common carp (Cyprinus carpio L.) exposed to Microcystis under laboratory conditions. Toxicon, 44 (8): 821-827.

Lockhart, W.L. and Metner, D.A. (1984): Fish serum chemistry as a pathology tool, pp. 73-86. In "Contaminant Effects on Fisheries". Vol. 16 (Cairns, V.W.; P.V. Hodson and J.O. Nriagu eds.) NY, Wiley Interscience.

Malbrouck, C.; Trausch, G.; Devos, P. and Kestemont, P. (2003): Hepatic accumulation and effects of microcystin-LR on juvenile goldfish Carassius auratus L. Comp. Biochem. Physiol., 135 C: 39-48.

McDonald, D.G. and Milligan, C.L. (1992): Chemical properties of blood. In "Fish Physiology". Edited by W.S. Hoar; D.H. Randall and A.P. Farrell. Academic press, NY., pp. 56-135.

McDonald, M.D. and Grosell, M. (2006): Maintaining osmotic balance with an aglomerular kidney. Comp. Biochem. Physiol., 143 C: 447-458.

Mehrle, P.M. and Mayer, F.L. (1985): Biochemistry/physiology. In: "Fundamentals of Aquatic Toxicology ". Hemisphere Publishing Corporation, NY.

Michael, M.I.; Hilmy, A.M.; El-Domiaty, N.A. and Wershana, K. (1987): Serum transaminase activity and histopathological changes in Clarias lazera chronically exposed to nitrite. Comp. Biochem. Physiol., 86 C: 255-262.

Mommsen, T.P. and Walsh, P.J. (1991): Urea synthesis in fishes: evolutionary and biochemical perspectives. In "Biochemistry and Molecular Biology of Fishes". Vol. I, "Phylogenetic and Biochemical Perspectives". (Hochachka, P.W. & Mommsen, T.P., eds), pp. 137-163. NY.: Elsevier.

Mommsen, T.P. and Walsh, P.J. (1992): Biochemical and environmental perspectives on nitrogen metabolism in fishes. Experientia, 48: 583-593.

Nabih, A.; Rashed, M.A. and Rizkalla, E.H. (2003): An experimental trail for infecting the scavenger catfish Clarias lazera with Trichinella spiralis larvae with special reference to certain fish biochemical reactions. Egypt. J. Aquat. Biol. & Fish., 7 (3): 173-195.

Nounou, A.H.; Soliman, M.M.; Rizkalla, E.H. and Assad, M.N. (1997): Haematological and biochemical changes in Clarias lazera as a result of long term exposure to a triad combination of lead, mercury and arsenic. Egypt. J. Agric. Res., 75 (1): 247-271.

Öner, M.; Atli, G. and Canli, M. (2008): Changes in serum biochemical parameters of freshwater fish Oerochromis niloticus following prolonged meta; (Ag, Cd, Cr, Cu, Zn) exposures. Environ. Toxicol. Chem., 27 (2): 360-366.

Palanivelu, V.; Vijayavel, K.; Balasubramanian, S.E. and Balasubramanian, M.P. (2005): Influence of insecticidal derivative (Cartap Hydrochloride) from the marine polychaete on certain enzyme systems of the fresh water fish Oreochromis mossambicus. J. Environ. Biol., 26: 191-196.

Peter, V.S.; Joshua, E.K.; Peter, M.C.S. and Wendelaar Bonga, S.E. (2007): Changes in the thyroid status modify the metabolite pattern of air-breathing perch (Anabas testudineus Bloch) during monocrotophos (Nuvacron) exposure. Comp. Biochem. Physiol., 146 A: S83.

Pimpão, C.T.; Zampronio, A.R. and Silva de Assis, H.C. (2007): Effects of deltamethrin on hematological parameters and enzymatic activity in Ancistrus multispinis (Pisces, Teleostei). Pest Biochem. Physiol., 88 (2): 122-127.

Randall, D.J.; Wood, C.M.; Perry, S.F.; Bergman, H.L.; Maloiy, G.M.O.; Mommsen, T.P. and Wright, P.A. (1989): Urea excretion as a strategy for survival in a fish living in a very alkaline environment. Nature, 337: 165-166.

Rizkalla, E.H. (1983): "Effect of Parasitic Infection on the Blood Constituents of Clarias lazera". M.Sc. Thesis (Animal Physiology), Faculty. of Sci., Alex. Uni

Rizkalla, E.H. (1988): "Effect of Some Food Additives on Some Biochemical and Physiological Parameters of Clarias lazera in Egypt". Ph.D. Thesis (Animal Physiology), Faculty. of Sci., Alex. Uni.

Rizkalla, E.H.; Yanni, A.A. and Ali, A.A. (1999): Incidence of Clostridium perfringens infection in catfish Clarias lazera and its effect on some biochemical and histopathological parameters. Alex. J. Vet. Sci., 15 (5): 1077-1096.

Rizkalla, E.H.; Fahmy, B.G.; Zaghloul, H.H.; El-Sadek, S.E. and Feisal, R.A. (2003a): Comparative study of some antibiotics on biochemical changes in plasma of the sharptooth catfish Clarias gariepinus. Egypt. J. Aquat. Biol. & Fish., 7 (4): 381-402.

Rizkalla, E.H.; Ghattas, M.W. and Badawy, E.A. (2003b): Effect of environmental factors on the parasitic helminthes-biochemical interrelationship in Clarias lazera in Lower Egypt. J. Egypt. Ger. Soc. Zool., (A) Comparative Physiology, 40: 297-314.

Roscoe Miller, W.; Hendricks, A.C. and Cairns, J.Jr. (1983): Normal ranges for diagnostically haematological and blood chemistry characteristics of rainbow trout (Salmo gairdneri). Can. J. Fish. Aquat. Sci., 40: 420-425.

Roy, S.S. (2002): Some toxicological aspects of chlorpyrifos to the intertidal fish Boleopthalmus dussumieri. Ph.D. Thesis, University of Mumbai, India, pp. 52-71.

Sandnes, K.; Lie, O. and Waagbo, R. (1988): Normal ranges of some blood chemistry parameters in adult farmed Atlantic salmon, Salmo salar. J. Fish Biol., 32: 129-136.

Sauer, D.M. and Haider, G. (1979): Enzyme activities in the plasma of rainbow trout, Salmo gairdneri Richardson: The effect of nutritional status and salinity. J. Fish Biol., 14: 407-412.

Shalabi, S.I.Y.; Kamel, A.A. and El-Azawi, M.H.S. (2000): Some biochemical and histopathological changes in plasma and tissues of Clarias lazera after exposure to copper sulphate application in a rice farm in Sharkia Governorate. Vet. Med. J., 48 (1): 117-134.

Singer, M.A. (2003): Dietary protein-induced changes in excretory function: a general animal design feature. Comp. Biochem. Physiol. B, 136 (4): 785-801.

Snedecor, G.W. (1971): "Statistical Methods". 14 th. (edn). Imes Iwa. The Iowa State Univ. Press., p: 593.

Soliman, M.K.; Zeinab A. Saad, Z.A.; Rizkalla, E.H.; Awad, Y.L. and Elias, N.S. (1991): Studies on serum proteins of Egyptian catfish Clarias lazera. Egypt. J. Agric. Res., 69 (4): 1011-1028.

Soliman, M.M.; Nounou, A.H.; Rizkalla, E.H. and Assaad, M.N. (1998): Monitoring of some heavy metals pollution in water and Clarias lazera fish at El-Gharbia and Kafr El-Sheikh Governorates. Egypt. J. Agric. Res., 76 (4): 1661-1669.

Stoskopf, M.K. (1993): Clinical pathology. pp. 113-131, In M.K. Stoskopf (ed.). "Fish Medicine". Saunders, Philadelphia.Thrall, M.A. (2004): "Veterinary Haematology and Clinical Chemistry". Vol. 19. Williams and Wilkins cap., Philadelphia, pp. 277-289.

Tisa, M.S. and Strange, R.J. (1983): Hematology of striped bass in fresh water. Prog. Fish-cult., 45: 41-44.

Vaglio, A. and Landriscina, C. (1999): Changes in liver enzyme activity in the teleost Sparus aurata in response to cadmium intoxication. Ecotoxicol. Environ. Saf., 43: 111-116.

Walsh, P.J. and Mommsen, T.P. (2001): Evolutionary considerations of nitrogen metabolism and excretion. In: Wright, P.A., Anderson, P.M. (Eds.), "Fish Physiology", Vol. 20. Academic Press, NY, pp. 1-30.

Walsh, P.J. and Smith, C.P. (2001): Urea transport. In: "Fish Physiology". (ed. Anderson, P.M. and Wright, P.A.). NY: Academic.

Warner, M.C. and Williams, R.W. (1977): Comparison between serum values of pond and intensive raceway cultured channel catfish Ictalurus punctatus (Rafinesque). J. Fish Biol., 11: 385-391.

Wedemeyer, G.A. and Nelson, N.C. (1975): Statistical methods for estimating normal blood chemistry ranges and variance in rainbow trout (Salmo gairdneri), shasta strain. J. Fish. Res. Bd. Can., 32: 551-554.

Wilkie, M.P. (2002): Ammonia excretion and urea handling by fish gills: present understanding and future research challenges. J. Exp. Zool., 293: 284-301.

Wood, C.M. (1993): Ammonia and urea metabolism and excretion. In: "The Physiology of Fishes". Evans, D.H. (Ed.). pp. 379-425. Boca Raton: CRC Press.

Yang, J. and Chen, H.C. (2003): Effects of gallium on common carp (Cyprinus carpio): Acute test, serum biochemistry, and erythrocyte morphology. Chemosphere, 53: 877-882.

Zikic, R.V.; Stajn, S.; Pavlovic, Z.; Ognjanovic, B.I. and Saicic, Z.S. (2001): Activities of superoxide dismutase and catalase in erythrocyte and plasma transaminases of goldfish (Caraccius auratus gibelio Bloch.) exposed to cadmium. Physiol. Res., 50: 105-111.

Table (2): Mean ± S.D. of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), Urea, uricacid and creatinine of Clarias garipinus collected from Barrage and Al-Aiat areas at winter season.

Item	Barrage area		El-Aiat area	
	Male (8)	Female (10)	Male (10)	Female (8)
γ-GT ($U\ l^{-1}$)	7.727 ± 3.743	7.040 ± 2.754	14.258 ± 8.214	15.036 ± 7.387^{b}
ALP ($IU\ l^{-1}$)	11.005 ± 1.293	10.420 ± 0.885	7.484 ± 3.102^{b}	$4.484 \pm 2.710^{*c}$
Urea (mg/dl)	33.059 ± 7.243	30.277 ± 7.696	19.992 ± 10.121	21.219 ± 3.909^{b}
Uric acid (mg/dl)	8.629 ± 3.068	8.639 ± 3.127	8.500 ± 0.981	7.700 ± 2.094
Creatinine (mg/dl)	1.827 ± 0.113	1.818 ± 0.138	1.185 ± 0.456^{b}	0.948 ± 0.370^{c}

Significant difference between two sexes in the same location: *: P < 0.05; **; P < 0.01 and ***: P < 0.001

Significant difference between two locations in the same sex: a: P < 0.05, b: P < 0.01 and c: P < 0.001

( ): Number of samples.

Table (3): Mean ± S.D. of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), Urea, uricacid and creatinine of Clarias garipinus collected from Barrage and Al-Aiat areas at spring season.

Item	Barrage area		El-Aiat area	
	Male (8)	Female (8)	Male (8)	Female (8)
γ-GT ($U\ l^{-1}$)	9.004 ± 4.806	14.948 ± 8.875	7.651 ± 3.557	13.303 ± 8.315
ALP ($IU\ l^{-1}$)	8.123 ± 0.751	7.988 ± 1.196	5.368 ± 2.977^{a}	6.296 ± 2.274
Urea (mg/dl)	20.666 ± 9.363	23.757 ± 9.468	35.673 ± 10.424^{b}	33.328 ± 15.295
Uric acid (mg/dl)	7.439 ± 0.717	$8.425 \pm 1.083^{*}$	8.056 ± 1.086	8.968 ± 1.973
Creatinine (mg/dl)	1.657 ± 0.361	1.432 ± 0.668	1.462 ± 0.320	1.281 ± 0.374

See footnote table (2)

Table (4): Mean ± S.D. of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), Urea, uric acid and creatinine of Clarias garipinus collected from Barrage and Al-Aiat areas at summer season.

Item	Barrage area		El-Aiat area	
	Male (8)	Female (8)	Male (11)	Female (7)
γ-GT ($U\ l^{-1}$)	7.752 ± 3.961	$15.317 \pm 6.200^{*}$	9.578 ± 5.641	7.046 ± 4.453^{a}
ALP ($IU\ l^{-1}$)	8.973 ± 1.322	8.145 ± 1.664	7.672 ± 0.951^{a}	7.795 ± 1.358
Urea (mg/dl)	34.400 ± 8.442	35.631 ± 11.223	13.598 ± 6.265^{c}	$20.516 \pm 6.603^{*b}$
Uric acid (mg/dl)	4.824 ± 1.243	5.814 ± 1.107	7.416 ± 0.583^{c}	7.614 ± 0.538^{b}
Creatinine (mg/dl)	1.489 ± 0.479	1.819 ± 0.209	1.494 ± 0.534	1.742 ± 0.289

See footnote table (2)

Table (5): Mean ± S.D. of serum gamma glutamyl transferase (γ-GT), alkaline phosphatase (ALP), Urea, uric acid, creatinine and creatinine of Clarias garipinus collected from Barrage and Al-Aiat areas at autumn season.

Item	Barrage area		El-Aiat area	
	Male (12)	Female (7)	Male (11)	Female (11)
γ-GT ($U\ l^{-1}$)	5.975 ± 4.539	6.618 ± 4.432	8.512 ± 3.965	8.359 ± 3.100
ALP ($IU\ l^{-1}$)	7.318 ± 0.807	7.277 ± 0.863	3.515 ± 1.525[c]	3.437 ± 1.454[c]
Urea (mg/dl)	21.284 ± 7.037	14.609 ± 5.772[*]	32.288 ± 6.237[c]	31.100 ± 4.460[c]
Uric acid (mg/dl)	6.663 ± 0.492	6.759 ± 0.757	6.962 ± 1.005	6.657 ± 1.401
Creatinine (mg/dl)	1.344 ± 0.481	1.789 ± 0.816	1.724 ± 0.052[a]	1.741 ± 0.063

See footnote table (2)

Table (6): ANOVA test for different serum biochemical parameters of both sexes of Clarias garipinus collected from Barrage and Al-Aiat regions in the four seasons.

Item	Barrage area		El-Aiat area	
	Male	Female	Male	Female
γ-GT	N.S.	N.S.	N.S.	N.S.
ALP	< 0.01	< 0.05	< 0.05	< 0.05
Urea	< 0.05	< 0.05	< 0.01	N.S.
Uric acid	< 0.05	N.S.	< 0.05	N.S.
Creatinine	N.S.	N.S.	N.S.	< 0.01

N.S.: Not significant

Table (7): Multiple ANOVA test showed the interactions between season, location and sex on data tabulated in tables 2 – 5 for different serum biochemical parameters of Clarias garipinus.

Item	Season X Location	Season X Sex	Location X Sex	Season X Location X Sex
γ-GT	< 0.05	N.S.	N.S.	< 0.05
ALP	< 0.05	N.S.	< 0.05	< 0.05
Urea	< 0.05	N.S.	N.S.	< 0.05
Uric acid	< 0.05	N.S.	N.S.	< 0.05
Creatinine	< 0.05	N.S.	< 0.05	< 0.05

N.S.: Not significant

Fig. (2): Seasonal changes of serum gamma glutamyl transferase (GGT) in *Clarias gariepinus* collected from Barrage and Al-Alat regions.

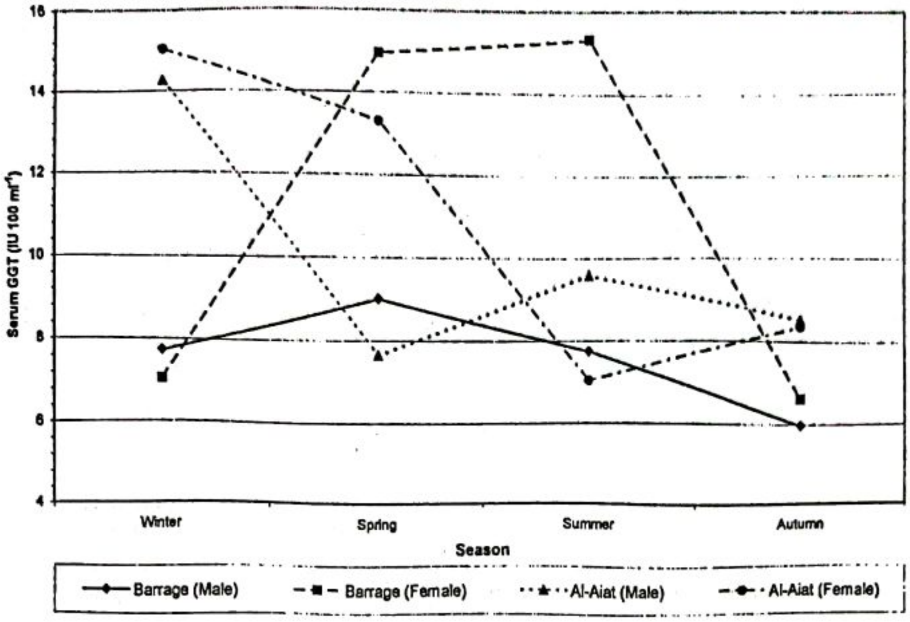


Fig. (3): Seasonal changes of serum alkaline phosphatase (ALP) in *Clarias gariepinus* collected from Barrage and Al -Alat regions.

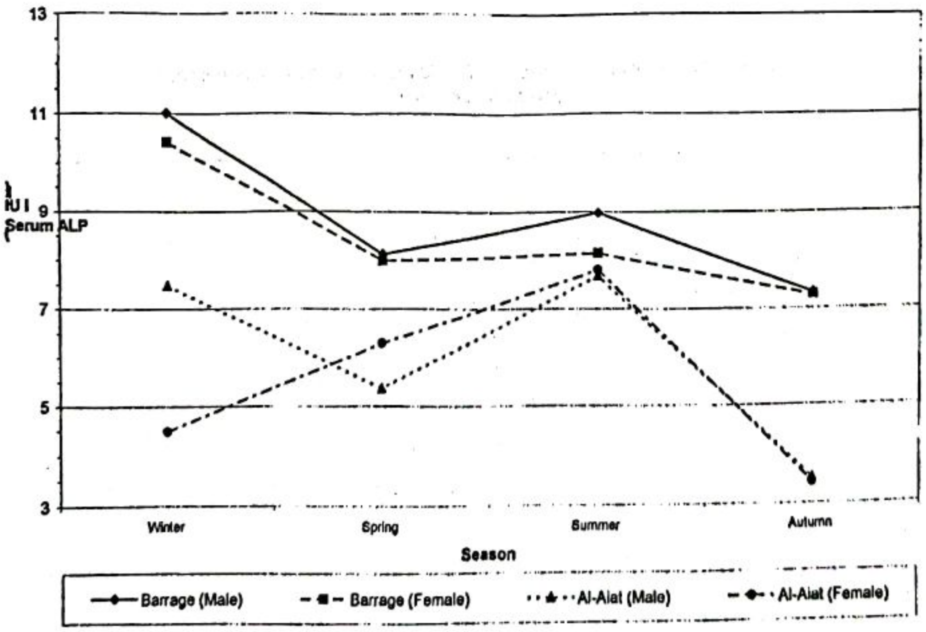


Fig. (4): Seasonal changes of serum urea in *Clarias gariepinus* collected from Barrage and Al-Alat regions.

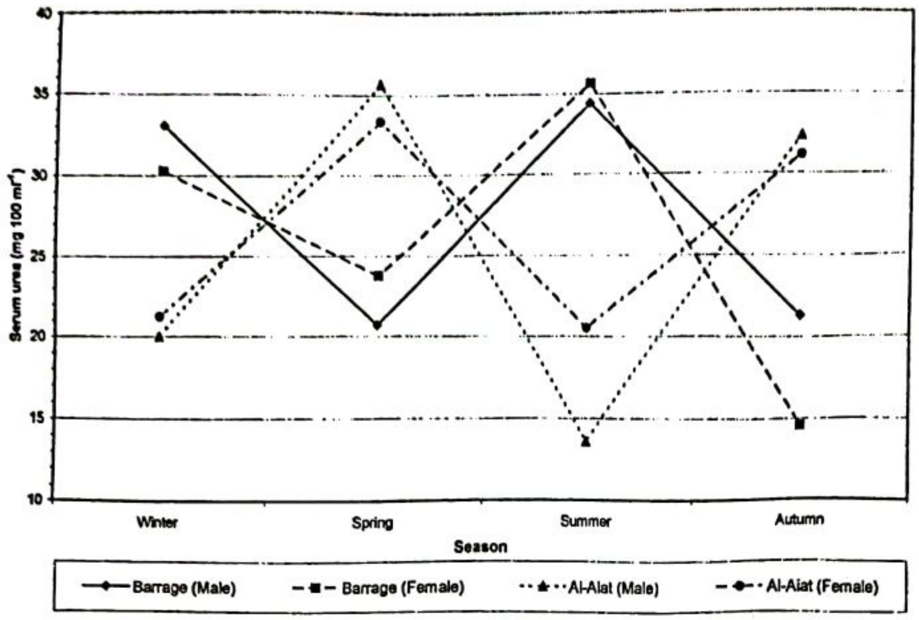


Fig. (5): Seasonal changes of serum uric acid in *Clarias gariepinus* collected from Barrage and Al-Alat regions.

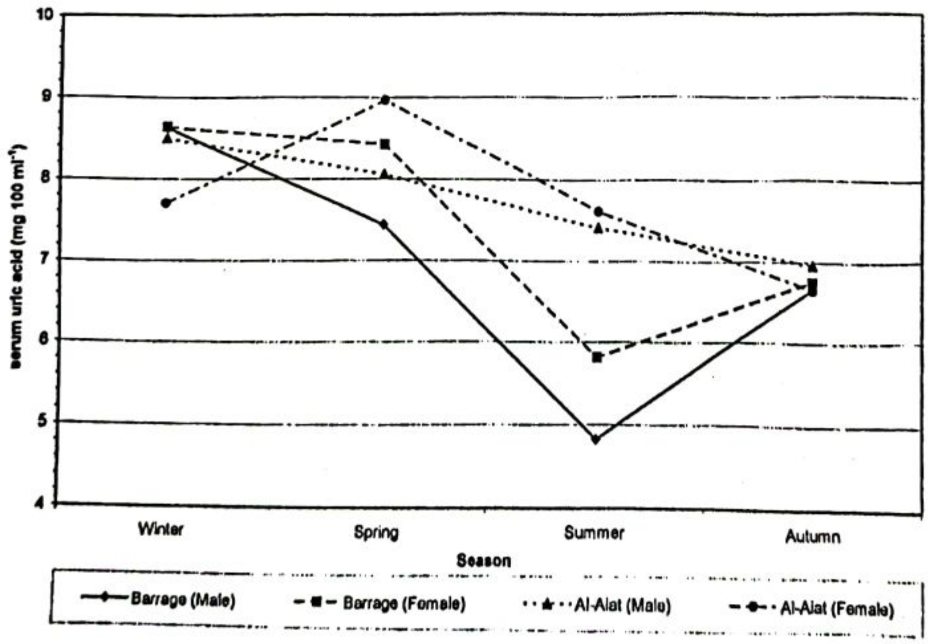
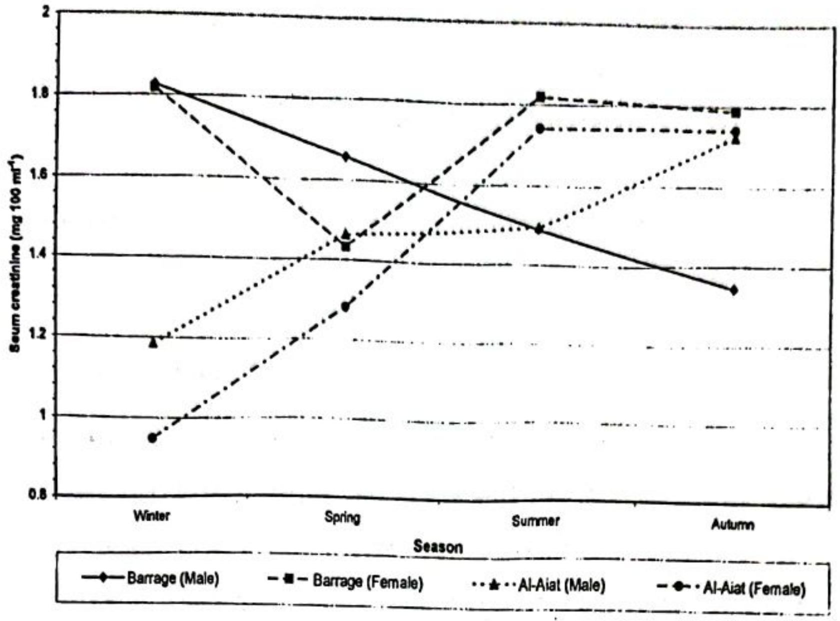


Fig. (6): Seasonal changes of serum creatinine in *Clarias gariepinus* collected from Barrage and Al-Aiat regions.



إختلافات المؤشرات البيوكيميائية لمصل دم سمكة قرموط النيل المجمعة جنوب وشمال منطقة القاهرة.
١) وظائف الكبد والكلى.

عصام حسنى رزق الله – باسم جرجس فهمى – فريال محمد نصر فضل الله

قسم الكيمياء الحيوية وأمراض النقص الغذائى والسموم – معهد بحوث صحة الحيوان – مركز البحوث الزراعية – الدقى – جيزة.

قسم علم الحيوان – كلية العلوم – جامعة الزقازيق – الزقازيق – شرقية.

يمكن لمصل الأسماك ان يظهر الكثير من التفاعلات البيوكيميائية للعمليات الأيضية المختلفة. كما يمكن للعديد من الضغوط البيئية ان تغير المؤشرات البيوكيميائية لمصل دم الأسماك. لذلك تم تجميع كلاً من جنسى سمكة قرموط النيل من منطقتى العياط والقناطر الخيرية جنوب وشمال مدينة القاهرة على التوالى لدراسة استجابة نشاط أنزيمى الجاماجلوتاميل ترانسفيريز والفوسفاتيز القلوى واليوريا وحمض البوليك والكرياتينين بمصل الأسماك للتغيرات البيئية طوال مواسم السنة الأربعة.

كل المؤشرات البيوكيميائية بمصل المجموعات السمكية المدروسة أظهرت نماذج متباينة للتأثير الموسمى عليها وكان التأثير نوعياً على نشاط أنزيم الفوسفاتيز القلوى فى كل المجموعات السمكية الخاضعة للدراسة أما التأثير الموسمى على اليوريا وحمض البوليك فكان نوعياً فى مصل الذكور المجمعة من منطقتى الدراسة ومصل الأناث من منطقة القناطر الخيرية لليوريا فقط. أما التأثير الموسمى على الكرياتينين فقد ظهر فى مصل أناث الأسماك المجمعة من منطقة العياط فقط. ولم يظهر أى تأثير موسمى على نشاط أنزيم الجاماجلوتاميل ترانسفيريز فى هذه الدراسة.

كان تأثير أختلاف المنطقة التى تم تجميع الأسماك منها نوعياً فى نشاط أنزيم الفوسفاتيز القلوى واليوريا وبدرجة أقل فى الكرياتينين. أما نشاط أنزيم الجاماجلوتاميل ترانسفيريز وحمض البوليك فكانا أقل المؤشرات بالمصل تأثرا بأختلاف مكان تجميع الأسماك.

تأثر أنزيمى الجاماجلوتاميل ترانسفيريز والفوسفاتيز القلوى واليوريا وحمض البوليك بجنس السمكة أما الكرياتينين فلم يتأثر مطلقا بأختلاف الجنس.

ظهر بوضوح ان هناك تأثيرا نوعيا على جميع المؤشرات البيوكيميائية فى مصل الأسماك المدروسة نتيجة الجمع بين التأثير الموسمى مع أختلاف أماكن تجميع الأسماك من ناحية ومع أختلاف أماكن تجميع الأسماك وجنس السمك معا من ناحية أخرى. بينما كان تأثير الجمع بين أختلاف أماكن تجميع الأسماك مع جنس السمك نوعياً على أنزيم الفوسفاتيز القلوى والكرياتينين. بينما لم يكن هناك أى تأثير من الجمع بين التأثير الموسمى مع جنس السمك على المؤشرات البيوكيميائية المدروسة بالمصل.