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IMPACT OF WATER QUALITY ON THE BLOOD PARAMETERS OF NILE TILAPIA IN DIFFERENT FISH FARMS

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ABSTRACT: Fish have high flexibility to live in diverse environmental conditions, since it have vast capability to be adjusted in adverse conditions. Such adjustments include increase of RBCs count, hematocrit (Hct) ratio and hemoglobin (Hb) concentrations, since blood is a perfect mirror apparently reflects health status of the fish. In the present studies, the blood picture of Nile tilapia reared in ponds of four different fish farms; (A) of Central Laboratory for Aquaculture Research (CLAR), supplied mostly with under-groundwater, (B) private fish farm supplied with agricultural drainage water, (C) of World Fish Center (WFC) irrigated with fresh water from Ismailia canal and (D) private fish farm supplied with sewage water from Bahr El-Baqar drain. It was found that, the erythrocyte's count of fish raised in fish farm (C) of WFC is the highest (1.859±0.091 10^6/µl) at summer in between other investigated fish farms. The same trend was also shown for haematocrit (Hct) %, its highest value (22.765 ± 0.813%) was recorded in tilapia of farm (C) at summer. These may be attributed to the adverse ecological parameters that influence on health status of the fish like dissolved O_2, pH, temperature and chemical pollutants present in the other fish farms. On the contrary, the haemoglobin (Hb) content showed its highest value (8.99±0.743g/dl) in fish of fish farm (D) supplies with water from Bahr El-Baqar drain, at spring. Regarding to the erythrocyte indices; mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) were varied in fish of the investigated fish farms. Their highest values (162.539±8.508 µ3, 69.790±6.212 Pg and 43.420±3.736 g/dl, respectively) were documented in fish farm (D) at autumn. These haematological indices are critical and serving as indicators of anemia. Nonetheless, the lowest values of these indices (128.247±5.860 μ^3, 36.835±2.620 Pg and 28.449±1.277 g/dl, respectively) were confirmed in fish farm (C) especially at winter, displaying almost healthy fish status.

Key words: Aquaculture, Nile tilapia, blood parameter, water pollution.

INTRODUCTION

Fish is very beneficial for human health, as according to American Heart Association (AHA) it is recommended for human twice a week (Kris-Etherton *et al*., 2002). It is of the high quality animal protein source, having essential fatty acids, which are much greater in fishes than in terrestrial animal food source (Weaver *et al*., 2008). So, it is the dominant source of animal protein in many developing countries (FAO, 2009).

Despite the fact that Egypt have abundant water bodies, nearly about 13.57 million faddans of different water qualities including the long coastline of the Mediterranean and Red Seas, as well as River Nile with its two main branches and tributaries, ten lakes of brackish and/or saline water in addition to the great lake of fresh water behind the High Dam, the Egyptian fish production already is not enough to cover local consumption of Egyptians, so the resolution is in aquaculture production (FAO, 2004).

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Aquaculture is the fastest growing sector in the field of fisheries and is considered as the only available for reducing the gap between production and consumption of fish in Egypt (Saleh, 2007). Aquaculture had been early known in Egypt back about to 3,000-2500 BC (Bardach *et al.*, 1972).

Regardless the rapid overpopulation of Egyptians the supply of aquaculture production has increased considerably faster, so the Egyptian per capita raised and reached about 16 Kg, just over the international average except that of china (Feidi, 2003; FAO, 2010). Since in 2012 Egyptian aquaculture production jumped to about 1,017,738 tonnes to constitute nearby 75.54% of the total Egyptian fish production (FAO, 2014).

Nile tilapia is the most important and promising aquaculture fish species in Egypt, representing more than 80% of total tilapias production (Sadek, 2011). Egypt ranked the second in cultured tilapia's production directly after China (Macfadyen *et al.,* 2012). Generally, Nile tilapia is the predominant cultured fish species worldwide even it is the only cultured tilapia species today (El-Sayed, 2013). This fish species is characterized by many features that make it more suitable for farming, it tolerates a varied range of environmental conditions, so minimal managements just needed for its culturing, consequently its farming is expanding world-wide (Nandlal and Pickering, 2004). It is characterize by fast-growing, palatability and high protein content, and acceptance of artificial feed directly after hatching (El-Sayed, 2006). Their musculature tissue does not contain any bones and has a scanty amount of fat (Shaheen, 2013). Nowadays, *Oreochromis niloticus* is the main cultured fish species in Egypt (Samy-Kamal, 2015).

The availability of water for aquaculture is the foremost limitation of its expansion. Egypt depends mainly for about 97% of its water supply on the Nile River which has threatened latter by abstraction and pollution (Allam, 2004). In addition to River Nile considerable groundwater aquifers as well as non-conventional water resources including agricultural drainage, sea water distillation, brackish water and municipal wastewater reuse are also playing non neglected role as water resources in Egypt (MWRI, 2005).

So in the present study, the impact of water quality in four fish farming of different water supply; fresh Nile water, ground water, agricultural drainage water and sewage water on the blood parameter of cultured Nile tilapia (*Oreochromis niloticus*) were discussed.

MATERIALS AND METHODS

In the present study, Nile tilapia (*Oreochromis niloticus*) cultured in four fish-farms irrigate with different water sources as the followings. Fish production farm (A) of Central Laboratory for Aquaculture Research (CLAR) supplied with under-groundwater (75%) and agricultural drainage water (25%). A private fish-farm (B) supplied with agricultural drainage water from Al-Bahnasawy drain and Fish-farm (C) of World Fish Center (WFC) irrigated with fresh water from Ismailia canal originating from the Nile River. All of these three fish farms are found in Abbasa, Abou-Hammad District, Sharkia Governorate, Egypt. However the fourth fish farm (D) is a private fish-farm at Shader Azzam, Port Said Governorate, supplied with sewage water from Bahr El-Baqar drain.

Fish Sampling

Nile tilapia (*Oreochromis niloticus*) specimens, about ten specimens, were collected in random pattern monthly around the year from March 2013 to February 2014. The monthly obtained data were transacted later to become seasonally. Immediately, from the selected live fish samples, blood was drained from the caudal vein by sterile syringe in vials using Ethylene-diamine-tetra-acetic acid dipotassium salt dihydrate (EDTA) as anticoagulant.

Erythrocyte Count (RBCs)

Accurately, in 0.5 ml of the blood anti-coagulated by EDTA by using a double haemocytometer, the erythrocyte count, expressed in million/μl^3, was obtained as described by Dacie and Lewis (1984).

Haematocrit Value (Hct)

It was determined by centrifuging the directly withdrawn heparinized blood, in the micro-haematocrit tube as recommended by Britton (1963), the haematocrit value (Hct) can be calculated by measuring the lengths of the layers and applying the following equation:

Hct = Vol. of cellular part/Whole vol. of blood sample × 100…….. (%)

Haemoglobin Content (Hb)

It was estimated by the colorimetric method using Boehringer Mannheim Kits and a spectrophotometer as described by (Vankampen, 1961).

Erythrocyte Indices

Erythrocyte status is also described by another derived three indices (Houston, 1990):

Mean cell volume (MCV)

Is the average volume of the red blood cells and derived from equation: MCV = Hct × 10 / RBCs (10^6/µl) … μ^3

Mean cell haemoglobin (MCH

Is the average haemoglobin content and calculated by equation: MCH = Hb × 10/RBCs (10^6/µl) .Pg

Mean cell haemoglobin concentration (MCHC)

Is calculated by the equation: MCHC = Hb × 100 / Hct ……..….. (g/dl)

Statistical Analyses

All values are given as Mean ± SE. Statistical differences among the means were calculated using ANOVA and Duncan's Multiple Range Test and considered statistically significant at p-values < 0.05 (Duncan, 1955). Estimations were statistically analyzed using student's t-test (2 ways) with the help of SPSS 17 software package for Windows.

RESULTS

The Erythrocyte Count (RBCs)

Erythrocyte's count of fish is of valuable interest. Its abnormal value is associated with fish disease and malformed conditions. In Nile tilapia of the present study, the erythrocyte counts were significantly differed (P < 0.05) in between fish farms. Its minimum value (1.418 ± 0.090 10^6/µl) was recorded in fish of fish farm (D) receipted water from Bahr El-Baqar drain but its maximum one (1.859 ± 0.091 10^6/µl) noticed in specimens of fish farm (C) supplied with fresh Nile water. Erythrocyte counts were also significantly varied, with the same (P < 0.05) too, between seasons, even in the same fish farms and ranged between (0.78±0.17 10^6/µl) as the most minimum value recorded in fish farm (D) at autumn and (2.37±0.54 106/µl) as the most maximum one documented in fishes of farm (C) at winter (Table 1).

However, in the other two farms, (A) supplied with almost underground water and (B) supplied with agriculture drainage water, the mean erythrocyte counts were in-between (1.499 ± 0.092 and 1.425±0.096 10^6/µl, respectively) as shown in Table 1.

Blood Hemoglobin Content (Hb)

In the current studies, the values of blood hemoglobin content (Hb) of Nile tilapia were non- significantly differed among investigated fish farms (P > 0.05) with a minimum (5.617 ± 0.290 g/dl) and maximum (8.990±0.743 g/dl) values noticed in fishes reared in fish farms (A) and (D), respectively. Similarly, the blood hemoglobin content was non-significantly varied (P > 0.050) in between seasons regardless fish farms, where the lowest (Hb) content (5.587 ± 0.329 g/dl) was detected at autumn and highest one (7.642±0.535 g/dl) was recorded at spring. Reviewing the general data, a vast fluctuation was recorded between the individual (Hb) readings, the minimum (3.86±0.42 g/dl) was noticed in fish farm (B) at autumn and the maximum (9.68 ± 1.07a g/dl) was noticed in fish farm (D) at spring as illustrated in Table 1.

Blood Hematocrit (Hct)

In the current studies it was found that, the hematocrit (Hct) values of the cultivated Nile tilapia were significantly differed (P < 0.050) in all fish farms among different seasons. Its minimum (11.67 ± 0.61%) and maximum (25.86 ± 2.67%) ratio were given at autumn and summer, respectively in the same fish farm fish farm (B) irrigated with agriculture drainage water. The average value of haematocrit around the whole year were also significantly diverged (P < 0.050) and ranged between 20.195±0.826%

Table 1. Erythrocyte count (10^6/ml), hemoglobin content (g/dl) and hematocrit value (%) in the blood of Nile tilapia specimens reared in the investigated fish farms in different seasons

Variable	Parameter	Erythrocyte count (10^6/µl)	Hemoglobin content (g/dl)	Hematocrit value (%)
		Fish farm effect		
Fish farm A		1.499^{b}±0.092	5.617^{b}±0.290	20.195^{a}±0.826
Fish farm B		1.425^{b}±0.096	6.695^{b}±0.688	20.541^{a}±1.248
Fish farm C		1.859^{a}±0.091	6.518^{b}±0.412	22.765^{a}±0.813
Fish farm D		1.418^{b}±0.090	8.99^{a}±0.743	21.792^{a}±1.104
Significance		0.000	0.061	0.017
		Season effect		
Spring		1.638^{a}±0.061	7.642^{a}±0.535	22.542^{ab}±0.545
Summer		1.703^{a}±0.081	6.794^{ab}±0.620	23.578^{a}±1.501
Autumn		1.152^{b}±0.133	5.587^{b}±0.329	16.565^{c}±1.017
Winter		1.538^{a}±0.131	7.044^{ab}±0.751	20.333^{b}±0.723
Significance		0.000	0.145	0.000
		Interaction between season and fish farm		
Fish farm A	**Spring**	1.78 ^{bcd}±0.15	5.09 ^{cd}±0.45	23.05 ^{abcd}±0.90
	Summer	1.84 ^{abc}±0.09	6.09 ^{abc}±0.94	21.81 ^{abcd}±3.59
	Autumn	0.99 ^{ef}±0.07	5.85 ^{abc}±0.58	15.86 ^{efg}±0.34
	Winter	1.27 ^{cdef}±0.05	6.18 ^{abc}±0.59	18.00 ^{def}±1.00
Fish farm B	**Spring**	1.70 ^{bcd}±0.10	9.54 ^{a}±0.84	21.82 ^{abcde}±1.19
	Summer	1.51 ^{bcde}±0.07	4.70 ^{bc}±0.83	25.86 ^{a}±2.67
	Autumn	0.99 ^{ef}±0.40	3.86 ^{c}±0.42	11.67 ^{g}±0.61
	Winter	1.19 ^{def}±0.03	7.43 ^{abc}±2.57	18.80 ^{bcdef}±0.66
Fish farm C	**Spring**	1.71 ^{bcd}±0.11	5.01 ^{bc}±0.44	20.20 ^{abcde}±0.83
	Summer	2.05 ^{ab}±0.09	8.19 ^{ab}± 0.95	24.91 ^{ab}±2.09
	Autumn	1.61 ^{bcd}±0.19	6.74 ^{abc}±0.37	22.86 ^{abcd}±1.01
	Winter	2.37 ^{a}±0.54	6.02 ^{abc}±0.46	24.67 ^{abc}±0.33
Fish farm D	**Spring**	1.47 ^{bcde}±0.11	9.68 ^{a}±1.07	23.85 ^{abcd}±1.05
	Summer	1.32 ^{cdef}±0.26	8.63 ^{ab}±1.87	18.49 ^{cdef}±4.44
	Autumn	0.78 ^{f}±0.17	5.73 ^{abc}±0.56	13.33 ^{fg}±1.20
	Winter	1.76 ^{bcd}±0.08	8.63 ^{ab}±0.93	22.50 ^{abcd}±0.29
Significance		0.024	0.002	0.000

* Significance versus group: $P<0.05$

(minimum), and 22.765±0.813% (maximum) in fish farms A and C, respectively. However, the seasonal hematocrit (Hct) average values were ranged between 16.565±1.017% and 23.578 ± 1.501%, at autumn and summer, respectively also with significant differences (P < 0.050) as illustrated in Table 1.

Red Blood Cell Indices

Mean cell volume (MCV)

Mean cell volume (MCV) is the average volume of red blood cells and expressed as cubic microns (μ^3). It is calculated from hematocrit (Hct) and the erythrocyte count (RBC). Low MCV indicates microcytic (small RBC size) but high MCV indicates macrocytic (large RBC size).

In the current studies, statistical non-significant variations (P > 0.05) of MCV parameter were documented for different fish farms at various seasons, even among the same fish farm, individually. The lowest MCV value (115.26 ± 24.84 μ^3) was documented in fish farm (C) at winter, but the highest value (179.45±21.87 μ^3) was recognized in fish farm (D) at autumn. MCV values of the reared Nile tilapia in the four fish farms around the year were trended as (D)> (B)> (A)> (C) with significant variation (P < 0.05). MCV values in between different seasons regardless fish farm were also significantly differed (P < 0.05) as shown in Table 2.

Mean cell hemoglobin (MCH)

The mean cell hemoglobin (MCH), is quantified the amount mass of hemoglobin per red blood cell and it expressed as picograms (pg) per cell. Presently, MCH was fluctuated between (29.24±8.65 Pg) in fish farm (C) at winter and (77.00±12.44 Pg) in fish farm (D) at autumn with non-significant variation (P > 0.050). However, MCH values were significantly differed (P<0.050) within the different fish farms with lowest annual value (36.835±2.620 Pg) and highest (69.790±6.212 Pg) for fish farms (C) and (D) respectively. Nevertheless, the MCH levels were non-significantly differed (P > 0.050) in between values calculated for different seasons irrespective fish farms (Table 2).

Mean cell hemoglobin concentration (MCHC)

MCHC indicates the amount of hemoglobin per red cell volume. It expressed as g/dl of red blood cells. Currently, MCHC was also differed significantly (P < 0.050) among all seasons in the examined four fish farms. Its minimum value (22.43±6.14 g/dl) was realized in fish farm (B) at summer but its maximum reading (54.72±15.28 g/dl) was given in fish farm (D) at summer also. The values of this erythrocyte index were varied also significantly (P < 0.050) in-between its annual values of different fish farms. Its highest value (43.420±3.736 g/dl) was recorded in fish of fish farm (D) but its lowest one (28.449±1.277 g/dl) was noticed in fish farm (C). In contrast, the MCHC values non significantly differed between seasons regardless fish farms (P > 0.050) with lowest value 32.783±4.028 g/dl at summer and highest one (35.460±4.227 g/dl) at winter (Table 2).

DISCUSSION

Fish have enormous flexibility to live in diverse environmental conditions; some species have vast capability to be adjusted in adverse conditions of temperature, pressure, salinity and oxygen availability. Such adjustments include ventilation frequency and heart rate in addition to increase of erythrocyte's count, hematocrit and hemoglobin concentrations (Val, 1996). Red blood cells count and their hemoglobin content together afford the foremost mechanism of oxygen carrying capacity of the blood (de Souza and Bonilla-Rodriguez, 2007). On the other hand, since fish lives collectively in water and only a thin epithelial membrane of gills and skin separates the blood of the fish from water of different qualities, so every unfavorable water quality should be reflected on the fish blood (Hlavek and Bulkely, 1980). Blood is a perfect mirror apparently reflects what occur inside fish body and can help to evaluate the health status of the fish (Shehata and Shehata, 1994). So, blood parameters such as number of erythrocytes counts, hemoglobin content and hematocrit percentage are used as warning alarm of adverse water quality (Shalaby, 1997; Fernandes and Mazon, 2003). Blood parameters are closely related to environmental and biological fish response, in addition to their easy for determination and therefor they are widely used for testing health problems of fish (De Pedro *et al*., 2005).

Table 2. Blood indices; Mean cell volume (MCV, μ^3), Mean cell hemoglobin (MCH) and Mean cell hemoglobin concentration (MCHC, %) of Nile tilapia specimens reared in the different investigated fish farms in different seasons

Variable	Parameter	MCV (μ^3)	MCH (Pg)	MCHC (g/dl)
Fish farm effect				
Fish farm A		143.241^{ab}±6.332	42.342^{b}±3.766	29.288^{b}±1.949
Fish farm B		153.060^{a}±7.002	50.315^{b}±4.860	34.901^{b}±3.411
Fish farm C		128.247^{b}±5.860	36.835^{b}±2.620	28.449^{b}±1.277
Fish farm D		162.539^{a}±8.508	69.790^{a}±6.212	43.420^{a}±3.736
Significance		0.032	0.001	0.004
Season effect				
Spring		146.638^{ab}±6.115	51.157^{a}±4.323	34.151^{a}±2.255
Summer		139.837^{b}±7.531	41.967^{a}±4.574	32.783^{a}±4.028
Autumn		163.054^{a}±8.252	57.524^{a}±4.881	34.702^{a}±1.890
Winter		139.018^{b}±5.475	49.680^{a}±6.603	35.460^{a}±4.227
Significance		0.034	0.138	0.912
Interaction between season and fish farm				
Fish farm A	**Spring**	140.57 ^{abc}±11.80	31.32 ^{c}±4.28	22.49 ^{c}±2.08
	Summer	117.02 ^{c}±15.73	32.61 ^{c}±3.63	28.68 ^{bc}±3.17
	Autumn	164.29 ^{abc}±9.14	62.39 ^{abc}±8.98	37.40 ^{abc}±4.44
	Winter	141.95 ^{abc}±4.99	49.32 ^{abc}±5.39	34.95 ^{abc}±3.79
Fish farm B	**Spring**	130.27 ^{abc}±5.98	56.29 ^{abc}±3.82	4366 ^{ab}±3.21
	Summer	169.43 ^{ab}±14.46	33.23 ^{c}±7.27	22.43 ^{c}±6.14
	Autumn	166.11 ^{abc}±23.95	54.58 ^{abc}±10.14	33.06 ^{bc}±3.25
	Winter	158.08 ^{abc}±2.41	62.79 ^{abc}±21.88	40.30 ^{abc}±14.58
Fish farm C	**Spring**	120.48 ^{bc}±4.45	30.07 ^{c}±2.70	24.79 ^{bc}±1.80
	Summer	122.59 ^{bc}±10.43	39.44 ^{abc}±3.39	32.77 ^{bc}±2.51
	Autumn	152.18 ^{abc}±14.77	46.41 ^{abc}±7.42	29.84 ^{bc}±2.11
	Winter	115.26 ^{c}±24.84	29.24 ^{c}±8.65	24.44 ^{bc}±2.16
Fish farm D	**Spring**	174.03 ^{a}±12.22	72.86 ^{ab}±8.98	41.55 ^{abc}±4.60
	Summer	135.86 ^{abc}±7.82	69.72 ^{ab}±15.75	54.72 ^{a}±15.28
	Autumn	179.45 ^{a}±21.87	77.00 ^{a}±12.44	43.03 ^{abc}±2.39
	Winter	128.60 ^{abc}±7.13	49.16 ^{abc}±5.24	38.44 ^{abc}±4.43
Significance		0.098	0.152	0.024

* Significance versus group: $P<0.05$

Nile tilapia, *Oreochromis niloticus*, reared in the present four investigated fish farms showed variable levels of blood parameters. Concerning the erythrocyte's count, it was found that, its highest value (1.859±0.091 10^6/µl) noted in fish farm (C) supplied with fresh water from Ismailia canal which was higher also than the values recorded for the same fish in other localities by Shalaby *et al*. (2006), Ghiraldelli *et al*. (2006) and Giron-Perez *et al*. (2008) and just lower than those reported by Sweilum (2006) and Silva *et al*. (2009). Nonetheless, the lowest count (1.418±0.090 106/µL) was observed in fish farm (D) supplied with water from Bahr El-Baqar drain followed by (1.425±0.096 10^6/µl) that of fish reared in fish farm (B) irrigated from agriculture drainage water then (1.499±0.092 106/µl) of fish reared in fish farm (A) of CLAR used underground water.

The same trend was also reported for hematocrit percentage, as its highest value (22.765 ± 0.813%) and lowest value (20.195 ± 0.826%) were recorded in fish farm (C) and (A), respectively and all lying within the values given by Ghiraldelli *et al*.(2006), Giron-Perez *et al*. (2008) and Silva *et al*. (2009) for the same fish in different localities with little differences. On the contrary, the hemoglobin blood content showed its highest value (8.99±0.743g/dl) in fish cultivated in fish farm (D) and the lowest (5.617±0.290 g/dl) was in fish reared in fish farm (A), followed by value (6.518±0.412 g/dl) of fish farm (C) comparable to values recorded by Shalaby *et al.* (2006) and Giron-Perez *et al.* (2008). The highest levels of erythrocyte number (1.703±0.081 10^6/µl) and hematocrit ratio (23.578±1.501%) were recorded in summer in comparison to other seasons. This was ratified by Sharma *et al*. (2015) and may be due to the higher water temperature and consequently high metabolic rate. Since, fish is ectothermic so, its hematological parameters are triggered primarily by water temperature and oxygen availability in addition to malnutrition and environmental stress (Acar *et al*., 2013; Pradhan *et al*., 2014).

The reduction of erythrocyte count, haematocrit ratio and hemoglobin content of Nile tilapia reared in the fish farm (D) in the present study can be attributed to haemodilution of blood due to damage and bleeding of fish organs (Movotny and Beeman, 1990) and/or the blood hemorrhage (Heath, 1995). This reduction of blood parameter was also detected in infected fish (Caruso *et al*., 2002) or that exposed to pesticides (Sweilum, 2006). It may also take place under the effect of high concentrations of ammonia (Adam and Agab, 2007; El-Sheriff and El-Feky, 2008) Chemical pollution also induced changes in blood cells of fish (Ebrahimi and Taherianfard, 2011). These deviations of fish blood parameters may be resulted in stimulation of the protective mechanisms against pollution (Ghiraldelli *et al*., 2006 ; Cazenave *et al*., 2009). Otherwise, Mlay *et al*. (2007) demonstrate that, the ecological factors especially dissolved O_2, pH, temperature directly affect hematological parameters. Similarly, the progressive fall of blood parameters of Nile tilapia, also displayed under the effect of unfavorable concentration of heavy metals (Zaghloul, 2008). These were realized in fish farm (D) of the current study, where its water and sediment metal pollution index reached the highest level (0.212 and 68.95, respectively) in addition of its highest level of ammonia concentration (0.747±0.089 mg/l) noticed at autumn both.

Regarding to the erythrocyte indices; mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) of Nile tilapia, they were varied in the four investigated fish farms. Their highest values (162.539 ± 8.508 µ3, 69.790 ± 6.212 Pg and 43.420 ± 3.736 g/dl), respectively were documented in fish farm (D). Nevertheless, their lowest values (128.247 ± 5.860 µ3, 36.835 ± 2.620 Pg and 28.449 ± 1.277 g/dl), respectively were verified in fish farm (C), all not far from values given by Shalaby *et al.* (2006), Giron-Perez *et al.* (2008) and Alsaid *et al.* (2014) for the same fish in different localities. The inverse correlation among hematological indices (PCV, MCV and MCH) of *Oreochromis niloticus,* of the present study, and water quality parameters are a result of the much higher count of RBCs in fishes reared in water of better qualities; this was also predicted by Adam and Agab (2007). Since, the RBCs count acts as denominator to calculate the hematological indices.

Far away from of this, blood indices (MCV, MCH and MCHC) are particularly important for the diagnosis of anemia in most animals (Coles, 1986). Anemia may by hemolytic, conveyed the less release of erythrocytes from haemopoietic tissues (Svobodova *et al*., 1994). Otherwise, the recorded decrease of MCV may lead to another type of anemia known microcytic anemia which means smaller size of erythrocyte than the normal. However, the decrease of (MCHC) and (MCH) may pave the way for hypochromic anemia which means a decrease in the fish blood color, as a result of decrease in erythrocyte hemoglobin content (Zuckerman, 2007). Hypochromic anemia as well as the microcytic one was assumed by DaCuna *et al*. (2011) following the decrease of erythrocytes count (RBCs) and hemoglobin content (Hb) as well as erythrocytes size (Hct) as measured by the MCV, MCH and MCHC indices. The values of these indices recorded in the current study indicated that any one of the mentioned types of anemia not detected in Nile tilapia reared in any of the investigated fish farm, since indices values were almost equal to those recorded in different localities by many authors. Pradhan *et al*. (2014) proved that, hematological indices are the most critical ones serving as indicators of fish health.

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تأثيـــر نوعيـــة الميـــاه علـــى دلالات الـــدم لأســـماك البلطـــى النيلـى فـــى المزارع السمكية المختلفة

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تتميز الأسماك بمرونة هائلة للعيش في الظروف البيئية المتنوعة والقدرة العالية على تعديل إمكانياتها الفسيولوجية ومنها دلالات الدم، كعدد خلايا الدم الحمراء (RBCs)، نسبة الهيماتوكريت (Hct) ومحتوى الهيموجلوبين (Hb) للظروف البيئية المعاكسة، فالدم مرآة تعكس ما تؤل إليه الحالة الصحية للأسماك، ويهتم هذا البحث بدراسة دلالات الدم ومؤشراته لأسماك البلطى النيلى المرباه فى أربعة مزارع سمكية مختلفة: (A) مزرعة المعمل المركزى لبحوث الأسماك بالعباسة والمزودة بمياه جوفية (٧٥%) و ثانية مزرعة خاصة (B) مزودة بمياه صرف زراعى والثالثة (C) مزرعة المركز العالمي للأسماك (WFC) والمزودة بمياه النيل العذبة من ترعة الإسماعيلية ثم أخيراً الرابعة (D) والتى تمد بمياه صرف صحى من مصرف بحر البقر، وأظهرت نتائج الدراسة أن عدد خلايا الدم الحمراء لأسماك البلطى النيلى المرباه في أحواض مزرعة المركز العالمي للأسماك (WFC) هو الأعلى على الإطلاق (١,٨٥٩ ± ٠,٠٩١/الميكرولتر المكعب) بين المزارع الأخرى الخاضعة للدراسة خاصة فى الصيف، وقد لوحظ الاتجاه نفسه بالنسبة لهيماتوكريت Hct دم أسماك مزرعة المركز العالمي للأسماك (٢٢,٧٦٥ ± ٠,٨١٣%) وهو أيضًا الأعلى في فصل الصيف كذلك، ويمكن أن يرجع ذلك إلى الخصائص السلبية لمياه مزارع الأسماك الأخرى مثل تركيز الأكسيجين الذائب، درجة الحرارة والحموضة وكذلك الملوثات الكيماوية والتي تؤثر على الحالة الصحية للأسماك المرباة، على العكس فمحتوى الهيموجلوبين (Hb) والذى أظهر أعلى قيمة (٨,٩٩ ± ٠,٧٤٣ جم / ديسيلتر) في الأسماك المرباه فى مزرعة الأسماك (D) والتى تمد بالمياه من مصرف بحر البقر، وفيما يتعلق بمؤشرات خلايا الدم الحمراء مثل متوسط حجم الخلية (MCV)، متوسط كم الهيموجلوبين فى الخلية(MCH) ومتوسط تركيز هيموجلوبين فى خلية (MCHC) فقد وجد أنها متنوعة في المزارع السمكية المختلفة، هذه المؤشرات الدموية حاسمة وتأخذ كمؤشر لفقر الدم وعلاجه، فقد كان أعلى قيمها (١٦٢,٥٣٩ ± ٨,٥٠٨ ميكرون مكعب و٦٩,٧٩٠ ± ٦,٢١٢ Pg و ٤٣,٤٢٠ ± ٣,٧٣٦ جم/ديسيلتر على التوالي) تم توثيقها في مزرعة الأسماك الخاصة (D) والتى تمد بالمياه من مصرف بحرالبقر خاصة في فصل الخريف، ومع ذلك فأدنى قيم هذه المؤشرات (١٢٨,٢٤٧ ± ٥,٨٦٠ ميكرون مكعب ، ٣٦,٨٣٥ ± ٢,٦٢٠ Pg و ٢٨,٤٤٩ ± ١,٢٧٧ جم/ ديسيلتر على التوالي كان فى مزرعة المركز العالمي للأسماك (C) خاصة في فصل الشتاء والدال على الوضع الصحي الجيد نوعا لهذه الأسماك.

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