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Editorial Board

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PREFACE

Dear readers of the Journal of Middle East and North Africa Sciences,

It is a great pleasure to publish this issue of the Journal of Middle East and North Africa Sciences for our readers. The issue is composed of 3 different papers having an acceptance rate of 88% in various disciplines of science. We would like to thank all authors, referees, our editorial board members and content editors that show efforts for the publication of the issue.

I would like to invite you to submit your manuscript/s to the next issue of the Journal of Middle East and North Africa Sciences.

Ahmad Saleh, PhD
Editor-in-Chief

New Esterases Amplification Involved in Organophosphate Resistance in *Culex Pipiens* Mosquitoes from Tunisia

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Abstract: In Tunisia, the mosquito *Culex pipiens* shows various organophosphate resistance alleles at Ester locus. Resistance to the organophosphate chlorpyrifos was investigated in one population of *Culex pipiens* collected in northwestern Tunisia. High resistance to chlorpyrifos was observed and new esterases were detected. These results must be considered in future mosquito control programs since detected esterases can lead to high resistance to several organophosphorus insecticides.

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Keywords: *Culex pipiens*, Tunisia, high resistance, chlorpyrifos, new esterases.

Short Report:

In most parts of Tunisia, mosquitoes have been subjected to organophosphate insecticide treatments since the mid-1960s, and resistance gene monitoring in the *Culex pipiens* complex (Diptera: Culicidae) started in only a few locations from the end of the 1980s (Ben Cheikh, 1999). The super-locus Ester is one of the two genome areas in the mosquito *Culex pipiens* involved in organophosphorus insecticide resistance (Lenomand et al, 1998; Bourget et al, 2004; Hanying et al, 2012). This super-locus is composed of two loci, Est-3 and Est-2, and both loci encode for detoxifying esterase. The resistance mechanism at Ester corresponds to an esterase over-production at one or both loci (Raymond et al, 1998; Bourget et al, 2004; Hanying et al, 2012). This study was conducted in order to assess the chlorpyrifos resistance status in Tunisia population of the *Culex pipiens* and to determine which resistance genes are associated with this resistance?

Culex pipiens were collected as larvae and pupae in the Governorate of Jandouba, northern Tunisia, in 2004. Resistance characteristics of larval population were determined by bioassays on fourth instar larvae, following the method described in Raymond & Marquine (1994). Reference strain used was S-LAB, insecticides susceptible strain without any known resistance genes (Georghiou et al, 1966). Chlorpyrifos insecticide (organophosphorus) was used in ethanol solutions. Mortality data were analysed by the log-probit program of Raymond (1993), based on Finney (1971). Esterase phenotypes were established by starch electrophoresis (TME 7.4 buffer system) as described by Pasteur et al. (1981, 1988) using homogenates of thorax and abdomen.

The linearity of dose–mortality responses was accepted ($P > 0.05$) for S-Lab and Jandouba population. RR at LC_{50} (RR_{50}) showed that the sample was resistant to chlorpyrifos. The RR_{50} reached a very high level with chlorpyrifos (RR_{50} = 8062). The addition of DEF (S,S,S-tributyl phosphorotrithioate) to chlorpyrifos bioassays did not decrease tolerance significantly ($P > 0.05$) in S-Lab and Jandouba sample. So, the increased detoxification by EST (and/or GST: Gluthations-S-Transferase) was not involved in chlorpyrifos resistance of this sample. However, Ben Cheikh et al, 2008 found an association between chlorpyrifos resistance and esterases.

A total of 20 mosquitoes were analyzed. Starch gel electrophoresis did not disclose any overproduced known esterase in the Jandouba samples. Two new patterns were observed (Figure 1). The first one (named New1 until further characterisation) displayed under esterase A1 and between A4/B4 and/or A5/B5. The second (New2) displayed under esterase A1. New1 and New2 are two new esterases and they are first detected in the present sample from 2004.

A new esterase, A13, characterised by the same electrophoretic migration as esterase A1 was identified in Tunisia by Ben Cheikh et al. (2009). New overproduced esterases detected could be responsible, at least partly, for the organophosphate resistance. In fact, theoretical studies showed that

new alleles allow low rates of resistance compared to those already known (Raymond et al, 1989). These results must be considered in future mosquito control programs since the detected esterases can lead to high resistance to several organophosphorus insecticides.

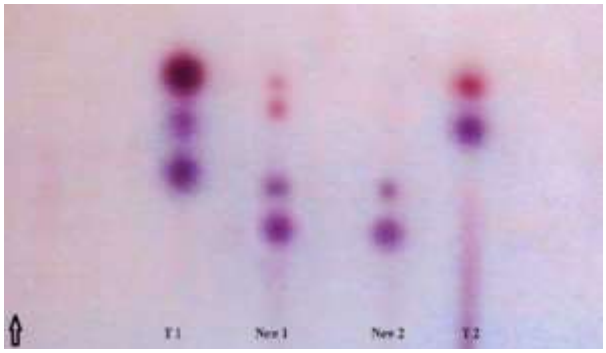

Figure 1. Activity esterases in single adults from the Jandouba sample analyzed on starch gel. The arrow indicates electrophoretic migration of the proteins. T1: A control mosquito displayed a phenotype with A2-B2/A4-B4 and/or A2-B2/A5-B5; T2: A control mosquito displayed a phenotype with A4-B4 and/or A5 -B5; New1 and New2: new esterases.

Declaration:

All authors declare they have no any conflicts of interests concerning on the report.

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Incidence and Causes of Anemia During Pregnancy in Antenatal Words in Khartoum University Hospitals

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ABSTRACT

Background: Anemia is one of the most commonly encountered medical disorders and a significant public health problem in developing countries, particularly in pregnant women. It is a cause of serious concern, besides many other adverse effects on the mother and the fetus it contributes significantly high maternal mortality. The aims of the study were to estimate the incidence of anemia and to assess the causes of anemia during pregnancy among pregnant women in Khartoum university hospitals.

Materials and Methods: Methods: This study was a descriptive hospital based study carried out among pregnant women attending antenatal wards at Soba University Hospital, and Saad Abo Alela Hospital during 15-31/December 2015, medical and obstetric data of the study population was collected using structured questionnaire. Hemoglobin was measured and Classified according to WHO anemia definition (hemoglobin [Hb]: <11 gm/dl classified as mild anemia (Hb:10—10.9 gm/dl), moderate anemia (Hb: 7.0—9 gm/dl), severe anemia (Hb: <7 gm/dl), respectively. Data was analyzed by using SPSS.

Results: Incidence of anemia among 68 pregnant women was (33.82%) as follow: 13.24% had mild anemia, 17.65% had moderate anemia and 2.94% had severe anemia , respectively, the main cause of anemia according to result were bad life style and nutritional deficiency and infection with UTI and malaria. (47%) of these were multi gravida, 73.53% had positive pica, all study population had low and moderate socioeconomic status, 57.35% had less than two years spacing between births and 2.94% with worm infestation were associated with anemia.

Conclusions: This study showed incidence of anemia, about one third of study population and majority of anemic women had moderate type of anemia. Bad life style, nutritional deficiency, infection with UTI, malaria, low and moderate socioeconomic status, and less than two years spacing period between births were common causes. Findings of this study call for urgent attention to provide solutions for direct and indirect causes of anemia. Routine testing of pregnant women for anemia and creating awareness campaigns on factors predisposing to anemia is recommended.

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Keywords: Anemia, Pregnancy, Maternal Mortality.

1. Introduction:

Anemia is a reduction in red blood cell volume, results in reduced capacity of the blood to carry oxygen to the vital organs of the mother and fetus, it is measured by hematocrit (Hct) or a decrease in the concentration of hemoglobin (Hgb) in the peripheral blood. Anemia is a sign of an underlying problem but does not indicate its origin (Ricci, & Kyle, 2009).

Anemia is a global public health problem, but is more prevalent in pregnant women and young children, as stated by WHO, (2015). Anemia among pregnant women worldwide was 38% and Sudan among countries, considered with a moderate type of anemia during pregnancy.

In 1992, Geneva & WHO defines anemia as Hb level below the normal range of 13.5g\dl (men), 11.5g\dl (women) and 11.0g/dl (children and pregnant women) (Geneva & WHO, 1992). CDC defines anemia in pregnant women as HB less than 11gm/dl in the first and third trimester and less than 10.5gm/dl in second trimester (CDC, 1989).

Anemia in pregnancy can be in different form as mention by Jacob, (2012). Physiological anemia of pregnancy, Pathological, Hemorrhagic, Hemolytic, Bone marrow insufficiency and

Haemoglobinopathies. But the common types of anemia are deficiency and hemorrhagic anemia (Jacob, 2012).

Anemia during pregnancy appear with clinical manifestations and signs and symptoms may be mistaken as minor disorders of pregnancy, patient may complain of weakness, exhaustion and lassitude, headache, nausea, vomiting, diarrhea, indigestion and loss of appetite, weight loss, depression, palpitation, dyspnea, giddiness, edema and, rarely, congestive cardiac failure can occur in severe cases, and sometimes with signs of pallor, glossitis, stomatitis, ulceration in mouth and tongue, edema due to hypoproteinemia, and hemorrhagic patches under the skin and conjunctiva (Sharma, & Shankar, 2010).

All pregnant women are at risk for becoming anemic, but the risk is higher in women with morning sickness, teenager, poor nutrition, history of anemia before pregnancy, women of childbearing age, frequent blood donors, vegetarians, hemolysis, pica (consuming nonfood substances), multiple gestation, and limited intervals between pregnancies (Jacob, 2012). In addition, Malaria increase severity of anemia mainly among primigravidae living in endemic areas (Matteelli et al., 1994). Serious impact of anemia on the health of the maternal and fetus depend on severity, speed of onset of anemia and degree to which oxygen is diminished, leading to miscarriages, preterm delivery, perinatal mortality, postpartum depression, preeclampsia, eclampsia increases the risks of hemorrhage, infection and the most common effect on the fetus are risk of preterm deliveries, low birth weights, morbidity and perinatal mortality from the impairment of oxygen delivery to placenta (Ricci, & Kyle, 2009).

Study conducted in eastern Sudan reported that 62% of the pregnant women had anemia (Hb < 11 g/dl), 52.4% had mild anemia; 8.1% had moderate anemia and 2.2% had severe anemia, respectively (Adam et al., 2005).

By determining incidence and causes of anemia among pregnant women better management approach can be recommended to help in prevention. Therefore, the main aims of this study were to study incidence, risk factors and causes of anemia among pregnant women admitted to antenatal wards in Soba University Hospital, and Saad Abo Alela Hospital.

2. Materials and Methods:

A descriptive hospital based study carried out randomly, among 68 pregnant women admitted to antenatal wards at Soba and Saad Abo Alela Hospital during 15-31/December 2015, data was collected using structured questionnaire. Hemoglobin was measured, according to Geneva & WHO, anemia definition as hemoglobin [Hb]: <11 gm/dl and classified to mild anemia (Hb:10—10.9 gm/dl), moderate anemia (Hb: 7.0—9 gm/dl), severe anemia (Hb: <7 gm/dl) and <4 g/dl (very severe anemia) Respectively.

Data was analyzed by using SPSS. Descriptive statistics were computed for all relevant variables. Association between anemia and some risk factors in pregnancy was tested using chi-square and multivariate analysis of risk factors was done. Permission from participants was taken.

3. Results and Findings:

Most of the study population age was between 20-40 years (80%), 42.65% of them, their level of education was university, two third of them, were housewives lived in urban area (77.94%, 69.12%) respectively, and 41.2% of them, have low Socioeconomic Status (Table 1).

Table 1. *Demographic Data of the participants.*

Age	Frequency	Percentage
Less than 20	11	16.18
20-30	32	47.06
31-40	23	33.82
41-50	2	2.94
Education		
Illiterate	3	4.41
Primary	14	20.59
Secondary	22	32.35
University	29	42.65
Occupation		
Employee	15	22.06
House wife	53	77.94
Residence		
Urban	47	69.12
Rural	21	30.88
Socioeconomic Status		
Low	28	41.2
Moderate	40	58.8

According to Geneva, & WHO classification, anemia experience among study population was 33.82%. Mild, moderate and sever as follow (13.24 %, 17.65% and 2.93%), respectively (Table 2).

Table 2. *Hb level among study population*.

HB level /gram	**Frequency**	**%**
11 and more	45	66.18
10-10.9	9	13.24
7-9.9	12	17.65
Less than 7	2	2.93
Total	68	100

Obstetric information of the study population, majority of them in the third trimester 58.8%, and

25% have an experience to one or two abortion with lack of preconception care, and Folic acid 7.4% and 5.9% respectively, and history of anemia found in 23.5% of pregnant women (Table 3).

Table 3. *Obstetric information of study population*

Items	%
Gravity (number of pregnancies):	
One	44.1
2-5	47.1
6-9	8.8
Parity (number of deliveries):	
One	11.8
2-5	36.8
6-9	7.4
History of abortion	
1-2	25
3-4	2.9
Type of pregnancies:	
Single	94.1
Twins	5.9
Pregnancy trimester	
First	13.2
Second	27.9
third	58.8
Space between children	
Less than one	22.1
Less than2	35.3
2and more	17.7
Antenatal care	
Regular	77.9
Preconception care	7.4
Folic acid	5.9
Hb regularly	75
History of anemia	23.5
History of malaria	7.4

Health problems that pregnant women suffer from it were UTI 38.3%, malaria 22.1%, bleeding 14.7%, hyperemesis 5.9%, vomiting 36.8%, and 73.53 experience pica (Table 4).

Table 4. *Health problem and pica among study population.*

Health problem	Frequency	%
UTI	26	38.3
Malaria	15	22.1
Worm	2	2.9
Vomiting	25	36.8
Diarrhea	2	2.9
Bleeding	10	14.7
Hyperemesis	4	5.9
Pica experience	50	73.53

The mean of pregnant women regarding their knowledge about anemia during pregnancy was 55.1%, percentages were as follow: their knowledge about definition of anemia was 82.4%, signs and symptoms was 54.41%, their knowledge about common types of anemia, risk of pregnant women to develop anemia and prevention of anemia during pregnancy was 32.35%, 85.3%, and 21.1% respectively (Table 5).

Table 5. *Pregnant women level of knowledge about anemia during pregnancy*

Knowledge about	Frequency	%
Definition of anemia	56	82.4%
signs and symptoms of anemia	37	54.41%
The most common type of anemia during pregnancy	22	32.35%
Pregnant women risk to develop anemia during pregnancy	58	85.3%
Prevention of anemia during pregnancy	14	21.1
Mean		**55.1**

In this study, no significant association between HB% and educational level, type of pregnancy, abortion and trimester of pregnancy.

4. Discussion:

Incidence of anemia in the current study was with HB% below 11g/dl, was (33.82%) which may be due to lack for seeking preconception care, take folic acid and antenatal advice. but it was less than what reported in El-Khurma Province in western Saudi Arabia, other studies in sudan, Baghdad Province, and Nigeria, they found that anemia in pregnant was 68.8%, 62.6%, 39.94%, 55.4%, 54.5% and, 40.8% respectively (Gedefaw, 2015; Abu Zaida et al., 2014; Adam et al., 2005; Al-Shawi et al., 2012; Olatunbosun et al., 2014; Abdelgadir,2012).

Anemia found in the current study higher than that reported in Southeast Ethiopia (27.9%) (Kefiyalew et al., 2014), and in north west Ethiopia were (21.6% and, 16.6%) respectively (Melku et al., 2014; Alem, 2013). In Turkey 2003-2004 was (27.1%) (Karaoglu et al., 2010), in Iran 2005-2007 was (4.7%) (Mirzaie, 2012), and Northern Nigeria 2009 was (17%) (Nwizu et al., 2011). This might be due to difference in the socio-demographic factors and lack of enough spacing period between children.

Anemia among pregnant women in this study was varied 13.24% had mild anemia, 17.65% had moderate anemia and 2.92% had severe anemia, this result agrees with (Gedefaw, 2015) in Southern Ethiopia, and in Western Saudi Arabia, findings

indicate that moderate anemia is more common 60% and 73.7% respectively (Abu Zaida et al., 2014). In contrast, in southeast and northwest Ethiopia 2013, in eastern sudan and Nigeria, they found that mild anemia is more common (55%, 64%, 52.4%, and 61%) respectively followed by other types of anemia (Kefiyalew et al., 2014; Olatunbosun et al, 2014; Adam et al., 2005).

Current study found that health problems among women as risk factors of anemia were UTI, multigravida, Malaria, bleeding and pica which agree with a study done by Adam et al. (2005), in eastern Sudan, who found that grand multigravida. Malaria and pica are the most common risk factor of anemia (Adam et al., 2005).

Malaria infection during pregnancy is life-threatening, in the current study, about 22.1% had malaria, with history of 7.4% had malaria in their previous pregnancies which might have contributed to the high prevalence of anemia as shown in eastern Sudan 13.7% (Adam et al., 2005). In Ethiopia Alem (2013) reports anemia was significantly associated with history of malaria attack (Alem, 2013).

Infection with malaria and UTI in the current study relatively high, this agree with a study done in Southeast Ethiopia (Kefiyalew et al., 2014). In addition, in the current study, 41.18% of a low socioeconomic status found among study population, which make them liable to acquired anemia as justify by Melku et al., (2014), who stated that mothers who have low monthly family income were three times more likely to be anemic as compared to those with high monthly family income, as income is low, the expenditure for food becomes low (Melku et al., 2014).

In the current study, Findings indicate that Interval between births less than one year found among 22.1% of participants, this lead to exhausted mothers, depleted iron and reduce Hb%. In addition, women did not have enough amount of nutritive diet, this could lead to anemia, beside 73.53% of study population had pica (non-nutritive food), which interfere with the absorption of iron and multivitamins, which lead to anemia, this result is agree with (Salih et al., 2015), who found pica is 67.3% among the pregnant women, and was higher than what reported by (Adam et al., 2005), in eastern Sudan 2003-2004, Adam et al. found (13.7%) practicing pica, which was significantly associated with anemia (Adam et al., 2005).

Half of the pregnant women their knowledge about anemia during pregnancy was good but their knowledge about prevention was only 21%, this make them liable to anemia.

Conclusion

Anemia is still a major health problem worldwide, and in Sudan. One third of the study population had different types of anemia but moderate was dominant. Infection with malaria and UTI, low socioeconomic, multigravida, pica, inadequate period between pregnancy, bad life style, and nutrition deficiency were existed among participants. Good knowledge level about anemia was found, but knowledge about prevention was poor. Findings of the current study call for urgent attention to provide solutions for direct and indirect causes of anemia. Routine testing of pregnant women for anemia and creating awareness campaigns on factors predisposing to anemia is recommended

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Proximate and Mineral Composition of Some Commercially Important Fishes in Jebl Awlia reservoir, Sudan

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Abstract: The proximate and mineral composition of the flesh of six commercially important fish species (Lates niloticus, Bagrus bayad, Oreochromis niloticus, Synodontis schall, Labeo niloticus and Hydrocynus froskalii) from Jebl Awlia reservoir, which represent different grades of preference to the Sudanese consumers, were studied to assess their nutritional values in order to gain the knowledge of the risk and benefits associated with the indiscriminate consumption of these fish species.
Protein content was in the range (71.46% -89.13 %) in the fish samples, crude fat was (6.34 % - 9.66 %) while moisture and ash were (75.33% -79.33 %) and (3.83 % -7.07 %) respectively. Minerals included potassium (200.0-774.0ppm), calcium (195.0-246.0ppm), sodium (184.0-211.0ppm), magnesium (144.0-105.0ppm) and phosphorus (90.0-240.0ppm) while iron and zinc were present in trace amounts. Levels of mineral elements in fish species were within WHO recommended limit. The data showed that the fishes are of high nutritional value and a good source of proteins and minerals.

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1. Introduction:

The nutritional characteristics of fish and fishery products are of vital interest to consumers. Fishery products are highly nutritious and excellent means of obtaining dietary essentials, like protein, minerals, and vitamins. In recent years, fish has become favorite foodstuff for the majority of societies because of several health reasons (Aberoumad, and Pourshafi, 2010).

Fish is a cheap source of high protein; so, there is a need to produce it as an alternative way of fulfilling animal protein requirement for the poor rural communities. Sutharshiny and Sivashanthini (2011), reported that fish received increased attention from time to time as a potential source of animal protein and some minerals for human diets. In addition to nutritional value, fish is also a good source of income.

The proximate composition of fish species is different among the fish species. Estimation of some proximate profiles of a fish such as protein, lipids, and moisture contents is often necessary to ensure that they meet the requirements of food regulations and commercial specifications. This knowledge of the biochemical composition of fishes is essential to estimate their energy value and to plan the most appropriate industrial and commercial processing (Teame et al., 2016).

The principal components of fish are; water, protein, lipid and carbohydrate (Waterman, 1980), while the following minerals are commonly found in fish: sodium, potassium, calcium, magnesium, phosphorus, Sulphur, iron, chlorine, silicon, manganese, zinc, copper, arsenic and iodine (Klein et al., 1993). The study of mineral elements present in living organisms is of biological importance. Many of such elements take part in some metabolic processes and are known to be indispensable to all living things (Shul'man, 1974).

Fish contains a small amount of these micro-nutrients some of which are essential nutrients, being components of many enzymes system and metabolic mechanisms that contribute to the growth of the fish. The most important micro-nutrients in form of mineral salts include Ca, K, P, Mg, Cl, while many others are required in trace amount. The deficiency in these principal nutritional mineral elements induces a lot of malfunctioning as it reduces productivity and causes diseases such as the inability of blood to clot, osteoporosis, anemia etc. (Shul'man, 1974, Mills, 1980).

Fish has an important role in food security and poverty alleviation in both rural and urban areas of Sudan, but little is known about the nutritional value of the Nile fish that is normally utilized either fresh or preserved dried, salted or smoked. Better knowledge of their nutritional value, which is expected to be closely associated with fish species, could contribute to the understanding of variability in meat quality of different species of the Nile fish. Therefore, in view of these facts, the present study was carried out on the commercial and most preferred species of the Nile fishes: Lates niloticus, Bagrus bayad, Oreochromis niloticus, Synodontis schall, Labeo niloticus and Hydrocynus froskalii in order to assess their proximate compositions and minerals contents prior to their consumption.

2. Materials and Methods:

2.1. Sample collection:

The fish samples used for this study include Lates niloticus, Bagrus bayad, Oreochromis niloticus, Synodontis schall, Labeo niloticus and Hydrocynus froskalii. They were obtained from Jebl Awlia reservoir, 45 Km south of Khartoum, Sudan. The fishes collected were virtually of the same size as variability in size stands to affect the proximate composition and the mineral elements concentration. All the samples were collected fresh and refrigerated below 4°C prior to use.

2.2. Chemical analysis:

Each fish sample was oven-dried in an electric oven at between 70 – 80°C until the sample had constant weight. From each composite sample, 2g were taken as an analytical sample. The determination of the percentage proximate composition was analyzed chemically according to the method of analysis described by the Association of Official Analytical Chemist (AOAC, 1995) while the percentage mineral elemental concentration was determined using (AAS) Atomic Absorption Spectrophotometer and calculated in ppm (µg/g dry weight).

2.3. Statistical data analysis:

Data were analyzed by descriptive analysis and one-way analysis of variance (ANOVA) to explore the general trend of the experimental data. SPSS (version 17.0) statistical software package (SPSS, Chicago, USA) was employed in the analysis. Differences were considered significant at an alpha level of 0.05. All means were given with ± standard deviation.

4. Results and Findings:

The result of the proximate composition of the fish samples is shown in Table 1. The values represent the mean of triplicate determinations and standard deviation. The moisture content range between 75.33±1.15 for Oreochromis niloticus to 79.30±1.15 for Synodontis schall and there was no significant difference ($p<0.05$) between the values for all the fish species. The ash content range between 3.83±0.14 for Oreochromis niloticus to 7.07±1.0 for Lates niloticus, there was no significant difference ($p<0.05$) between the values for all the fish species. The protein content showed highest value (89.13±2.10) for Lates niloticus and least value (71.46±2.0) for Oreochromis niloticus. The crude protein content of all the fish species followed a decreasing order: Lates niloticus > Hydrocynus froskalii > Bagrus bayad > Labeo niloticus > Synodontis schall > Oreochromis niloticus. The fat content values showed in a significant difference ($p<0.05$) among the fish species with Synodontis schall having the highest value (9.66±0.56) and Hydrocynus froskalii had the least (6.34±0.87). The crude fat content for the fish species followed a decreasing order: Synodontis schall > Lates niloticus > Labeo niloticus > Bagrus bayad > Oreochromis niloticus > Hydrocynus froskalii.

Mineral contents of all the fish samples are shown in Table 2. The mean values and standard deviation of triplicates are determinations for the mineral content of the fish samples. The Calcium content varies for the fish species with the least value (195.0±0.01ppm) and the highest value (246.0±0.01ppm) obtained for Lates niloticus and Hydrocynus froskalii respectively. Magnesium ranges from 144.0±0.04ppm in Hydrocynus froskalii to 452.0±0.06ppm in Oreochromis niloticus. The highest amount of sodium was observed in Hydrocynus froskalii (648.3±0.01ppm) while Bagrus bayad contains the least amount of sodium (184.0±0.01ppm). Potassium also ranges from 774.0±0.02ppm in Lates niloticus to 200.0±0.02 in Synodontis schall. The highest amount of phosphorus was observed in Bagrus bayad (240.0±0.01ppm) while the least amount was (90.0±0.006ppm) in Synodontis schall. The results showed that the most abundant macro elements present in all the fish samples were sodium followed by magnesium, potassium calcium, and phosphorus respectively. Iron was the most abundant micro element in the fish. The iron content of the fish species ranged between 2.0±0.06ppm and 8.0±0.04ppm in Bagrus bayad and Labeo niloticus respectively. There was no significant difference ($p>0.05$) between the values of the iron contents.

Table 1. *The percentage means proximate composition in the body tissue of some selected fish species (g/100g)*

Parameter % Fish samples	Moisture	Ash contents	Crude protein	Crude fat
Lates niloticus	77.33±2.3	7.07±1.00	89.13±2.10	9.61±0.56
Bagrus bayad	78.33±2.9	5.74±0.36	84.89±0.80	8.63±0.69
Oreochromis niloticus	75.33±1.15	3.83±0.14	71.46±2.00	8.52±0.69
Labeo niloticus	76.00±2.0	5.50±0.98	75,00±0.10	9.08±0.85
Hydrocynus froskalii	76.66±2.3	4.16±0.14	82.86±3.00	6.34±0.87
Synodontis schall	77.33±2.3	5.11±0.20	78.34±0.37	9.66±0.56
Sign. level	NS	NS	NS	NS

*Values represent pooled means and standard deviations of triplicate determinations of wet weight.
**NS values represent not significantly different.

Table 2. *The percentage means of mineral elements in the body tissue of some selected fish species (ppm)*

Elements Fish samples	Potassium K	Calcium Ca	Sodium Na	Magnesium Mg	Phosphorous P	Iron Fe
Lates niloticus	**774±0.018**	**195±0.01**	**449±0.01**	**105±0.06**	**190±0.01**	**7.00±0.01**
Bagrus bayad	**219±0.038**	**242±0.27**	**184±0.01**	**241±0.18**	**240±0.01**	**2.00±0.06**
Oreochromis niloticus	**220±0.018**	**226±0.01**	**429±0.01**	**452±0.06**	**140±0.01**	**4.00±0.07**
Labeo niloticus	**321±0.01**	**237±0.01**	**369±0.01**	**258±0.06**	**210±0.01**	**8.00±0.04**
Hydrocynus froskalii	**260±0.018**	**246±0.01**	**648±0.01**	**144±0.040**	**160±0.06**	**3.00±0.06**
Synodontis schall	**200±0.018**	**196±0.01**	**211±0.01**	**235±0.010**	**90.0±0.06**	**5.00±0.07**
Sign. level	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*Values represent pooled means and standard deviations of triplicate determinations of wet weight
**NS values represent not significantly different

5. Discussion:

The nutritional composition of freshwater fish is known to vary with species, sex, size, season and geographical location (Zenebe et al., 1998). Additional factors that influence nutritional composition include feed intake and sexual changes associated with spawning (Silva and Chamul, 2000). In the present study, the species investigated are the popular market fishes in Khartoum and economically belong to the different traditional grades, according to consumer and fishermen preference in Sudan. The nutritional elements showed variable values in the species analyzed; with crude protein recording the highest values and lipid recording the lowest. This makes the Nile fishes important living resources of dietary protein as other sea and freshwater fish (Zuraini et al., 2006).

Generally, the proteins are essential for normal function, growth, and maintenance of body tissue and hence protein content is considered to be an important tool for the evaluation of biochemical and physiological standards of a given organism (Banu et al., 2016). Protein content was slightly higher in the muscle of Lates niloticus than in the other five species. Although slight variations were observed for the protein levels and statistically no significant difference (P>0.05), indicating that protein levels were the same in the species. The results of the range of protein content were within the range of variations reported by Zelibe (1989). The fish species examined belonged to high protein, low fat category, because the protein contents were between 71 to 89%DW and fat 6.0 to 9.0% DW (Stansby, 1982). The high tissue protein content of the fish species in this study may be related to the high protein contents of their common diets as they fed mostly on fish items, crustaceans, molluscs, algae and diatoms (Osibona, 2005).

Crude fat content, in particular, has been observed to fall into the category of lean fish (Srivastava, 1999). High lipid fishes had less water and more protein than low-lipid fishes. This is in-line with the report of Steffens (2006), that protein forms the largest quantity of dry matter in fish. The difference in the value of crude fat level in the fish species could be due to water temperature difference, stage of life, environmental salinity, food type, and species (Sánchez, 2012). This study found the percentage ash content, is an indication of ample mineral content in fish. The ash contents for all samples examined (Table 1) were not significantly different (p>0.05) and the values were not above the World Health standard.

Results showed all the fish samples contained appreciable concentrations of potassium, sodium, magnesium, calcium and phosphorus suggesting that these fishes could be used as good sources of minerals. The variations recorded in the concentration of the different mineral components in the fish examined could have been as a result of the rate in which these components are available in the water body (Yeannes and Almandos, 2003), and the ability of the fish to absorb and convert the essential nutrients from the diet or the water bodies where they live. This is supported by the findings of (Windom et al. 1987; Puwastien et al., 1999; Ali et al., 2001; Ako and Salihu, 2004; Fawole et al., 2007).

The richness in phosphorus level in the five species can also be attributed to the fact that phosphorous is a component of protein. The concentration of the microelement and iron were analyzed for the fish samples, were not statistically different at (p>0.05) between the fish species. Iron is an essential component of the respiratory pigments and myoglobin, also is an important constituent of hemoglobin (Onwordi et al., 2009). This microelement is equally important in trace amounts as observed, but they tend to become harmful when their

concentration in the tissues exceed the metabolic demands (Ako and Salihu, 2004). The iron contents for the fish samples are within the World Health standard.

6. Conclusion:

The study of the proximate composition of Lates niloticus, Bagrus bayad, Oreochromis niloticus, Synodontis schall, Labeo niloticus and Hydrocynus froskalii revealed that they are rich in protein, minerals and have average to low lipid contents. This study has shown these fish species from Jubl Awlia, Sudan as a good source of nutrients to the consumers and within the limits required by the body for healthy growth and development. The study has also provided an insight into the mineral content of these species in line with food safety when consumed. Since the nutritional value of these fish samples has been known, consumers can now know the benefit to derive when these fishes are consumed. The result obtained in this study has provided scientific information and detailed knowledge of the proximate composition and minerals of these six important commercial fish species.

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