

**FATTY ACIDS COMPOSITIONS IN THE LIVER AND FAT OILS OF
THE SPINY-TAILED LIZARDS *UROMASTYX DISPAR* AND *U.
OCELLATA* (SAURIA: AGAMIDAE)**

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ABSTRACT

Fatty acid composition and profile in the fat and liver oils of the spiny-tailed lizards *Uromastyx dispar* and *U. ocellata* (Sauria: Agamidae) were determined by gas chromatography. Twenty-three and 13 FA were identified in fat and liver oil, respectively. Palmitic acid was the predominant SFA in the both fat and liver oils. Myristic and tricosanoic are the second dominants with higher levels in fat compared to liver oil. Oleic, palmitoleic and eicosenoic acids were the prevailing MUFAs, respectively, (5.7%, 5.1% and 4.5%) in fat oil, (12%, 11.4% and 10.4%) in the liver oil. Eicosatrienoic and lenolenic were the major PUFAs in fat oil (7.9%, and 7.7%), respectively, lenolenic and lenoleic acids were the dominant PUFAs in liver oil (12.7% and 12.1%), respectively. The percentage of EPA was (3.9%) and DHA was (1.8%) in fat oil, but none of the two acids were detected in liver oil. The fat oil contained equal amounts of SFAs and USFAs. In the liver oil UFAs were about three folds (75.5%) the SFAs (25.5%) and MUFAs accounted for of (41%) of TFA. The UFA/SFA ratio as recommended by nutritionists is 3; in the fat and liver oils of the lizard this ratio was, respectively, 1.0 and 3.1. The fat and liver oils contained same percentage (13%) of n-3 and n-6, the liver oil contained more n-6 (22%) than the fat oil (12%). The n-3/n-6

ratio was (1.1) in the fat oil and (0.6) in the liver oil. The overall significance of this study had been its revelation that *Uromastyx* fat and liver oils contain appreciable levels of FA and are better sources of essential fatty acids ω -3 EFA while the liver is a good source of ω -6 EFA.

Keywords: EFA, MUFA, N-3/N-6, PUFA, UFA/SFA, *Uromastyx*

Running title: Fatty acids in liver and fat tissues of *Uromastyx lizard*.

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INTRODUCTION

Uromastyx (spiny-tailed lizards) is a genus of agamid lizard whose members are known as uromastyxes, mastigures, or dabb lizards. *Uromastyx* are primarily herbivorous, but occasionally eat insects, especially when young. They spend most of their waking hours basking in the sun, hiding in underground chambers at daytime or when danger appears. They tend to establish themselves in hilly, rocky areas with good shelter and accessible vegetation. *Uromastyx* inhabit a range stretching through most of North Africa, the Middle East, ranging as far east as Iran and southern Iraq (Wilms, 1998). In the most recent

revision of the genus *U. ocellata* was found to be wide spread and regionally abundant (Wilms and Bohme, 2000, 2001) Two species of *Uromastyx* are known from Sudan: *Uromastyx dispar* Heyden, 1827, and *U. ocellata* Lichtenstein, 1823 (Mohammed and Hammad, 2008). These agamid lizards are regularly eaten and sold in produce markets by local peoples, especially Bedouins of central and northern Arabia (Abu-Tarboush, et al., 1996_a). Hunting of dabb lizard still exists in Arabia, because it is considered a delicious meat that provides strength.

In a study conducted by Abu-Tarboush, et al. (1996_b) on the meat of *U. aegyptius*, the meat was found to contain high protein (82.64%) and cholesterol but low levels of fat and saturated fatty acids. The nutritional quality and protein characteristics were also studied by Abu-Tarboush, et al. (1996_a), where low levels of some amino acids were recorded. However, since this lizard is still traditionally eaten in some African and Arab countries, more studies are needed to verify the nutritional quality of its different edible parts. There is much information available on the fatty acid composition of the lipids present in meat oil of many edible animals while very little is published on fatty acid contents of these lizards. Analysis of fatty acids profile provides information about the essential fatty acids contents of *Uromastyx* lizards which are willingly consumed. The liver and fat oils may provide a rich and underexploited source of polyunsaturated fatty acids, including essential omega-3s and omega-6s, thus increasing the commercial value of the lizard. The consumption of the highly unsaturated fatty acids: eicosapentaenoic (C20:5n-3) and docosahexaenoic (C22:6n-3) is linked to the development of the brain and nervous tissue in infants and visual function, and reduces the incidence of coronary heart disease (Uauy et al., 2001; Innis, 2004; Shahidi and Miraliakbari, 2004). Therefore, the objective of this work was to investigate the fatty acid

composition and profile (%) in the liver and fat tissues (oils) of the *Uromastyx* and to verify the nutritional quality of oil from this agamid lizard.

MATERIAL AND METHODS

Collection of samples

Ten specimens of *Uromastyx* (*U. dispar* and *U. ocellata*) were taken from the living collection of the Sudan Natural History Museum. All specimens were previously obtained from Abu Hammad in the Nile State in the north of the Sudan. Each lizard was dissected and the livers and fat were removed and kept in clean containers till used for analysis. The livers and fat samples of the two species were pooled and homogenizing in a mechanical blender with a mixture of chloroform and methanol (2:1 v/v). Methyl esters of fatty acids were prepared for subsequent use in gas-liquid chromatography. Triplicate samples (10g) were taken from the homogenized liver and fat and lipids were extracted by the procedure of Folch et al. (1957)

Fatty acids analysis

Fatty acids were analyzed as their methyl esters with a gas chromatography mass spectrometry (GC-MS; Hewlett- Packard 5890 GC), according to the procedure of Ahlgren et al. (1994). Fatty acids were identified by comparison with the retention time of standards (Supelco, PUFA-3), and the concentration of individual fatty acid was calculated using heneicosanoic acid (C21:0) as internal standard. The results are presented as the (means \pm

standard deviation, SD) of triplicate determinations of liver tissues (mg/ g) and weight percentage of the total fatty acids (%TFA).

RESULTS AND DISCUSSION

The fatty acid composition and percentage in the fat and liver oil of *Uromastyx* are listed in Table 1. Twenty-three fatty acids were identified in the fat oil and only thirteen fatty acids were identified in the liver oil. The data show that the amount of constituent fatty acids varied among the two tissues (Figure 1). Of the saturated fatty acids (SFA), palmitic (C16:0) was the predominant SFA in the both fat and liver oils. Myristic (C14:0) and tricosanoic (C23:0) are the second dominants with higher levels in the fat compared to liver oil. Oleic (C18:1n-9), palmitoleic (C16:1) and ecosenoic (C20:1) acids were the most prevailing monounsaturated fatty acids (MUFA) and they were higher ($P < 0.001$) in the liver oil (12%, 11.4% and 10.4%), respectively, than in the fat oil (5.7%, 5.1% and 4.5%). The percentage of polyunsaturated fatty acids (PUFA) for fat and liver oils was (22.7% and 34.5%), respectively. Eicosatrienoic (C20:3n6) and lenolenic (C18:3n3) were the major PUFA in fat oil (7.9%, and 7.7%), respectively, whereas, Lenolenic (C18:3n3) and lenoleic (C18:2n6c) acids were the dominant PUFA in liver oil (12.7% and 12.1%), respectively. The percentage of EPA was (3.9%) and DHA was (1.8%) in fat oil, but none of the two acids were detected in liver oil.

The contents and percentages of SFA, MUFA and PUFA in the fat and liver oil of *Uromastyx* are shown in Table 2. The contents and percentages of SFA and USFA groups were almost

same in fat oil (Figure 2). In the liver oil UFA was about three folds (75.5%) the SFA (25.5%), whereas MUFA accounted for the highest proportion of FA (41%). As shown in Figure (3), the fat and liver oils have the same percentage of n-3 fatty acids (13%), but the percentage of n-6 fatty acids was higher in the liver oil (22%) than the fat oil (12%). The n-3/n-6 ratio was (1.1) in the fat oil and (0.6) in the liver oil.

Table 1. Fatty acids contents (mg/g \pm SD) and profiles (%TFA) in fat and liver oils of *Uromastix* lizard.

Fatty acids	Fat		Liver	
	mg/g	%	mg/g	%
Myristic C14:0	11 \pm 2.1	11	4 \pm 1.8	4
Pentadecanoic C15:0	6 \pm 1.3	6	0	0
Palmitic C16:0	18 \pm 3.1	18	15.4 \pm 2.8	15
Heptadecanoic C17:0	1.6 \pm 0.4	1.6	1.9 \pm 0.6	1.9
Stearic C18:0	1.2 \pm 0.3	1.2	2.6 \pm 0.9	2.6
Arachidic C20:0	1.6 \pm 0.2	1.6	0	0
Behenic C22:0	2 \pm 0.7	2	0	0
Tricosanoic C23:0	8.4 \pm 2.1	8.4	1.4 \pm 0.1	1.4
Myristoleic C14:1	1.8 \pm 0.5	1.8	0	0
Pentadecanoic C15:1	3.5 \pm 1.1	3.5	4.9 \pm 1.9	4.8
Palmitoleic C16:1	5.1 \pm 1.7	5.1	11.5 \pm 3.4	11.4
Heptadecanoic 17:1	2.1 \pm 0.2	2.1	2.7 \pm 1.3	2.6
Oleic C18:1n9c	5.7 \pm 1.9	5.7	12 \pm 2.1	12

cis-Ecosenoic C20:1	4.5 ± 1.8	4.5	10.5 ± 3.2	10.4
Linolelaidic C18:2n6t	1.1 ± 0.2	1.1	10 ± 2.5	10
Lenoleic C18:2n6c	2.1 ± 0.2	2.1	12 ± 3.1	12
Lenolenic C18:3n3	7.7 ± 2.4	7.7	13 ± 3.8	13
Eicosadienoic C20:2	1.8 ± 0.9	1.8	0	0
Eicosatrienoic C20:3n6	8 ± 2.7	8	0	0
Arachidonic C20:4n6	0.7 ± 0.3	0.7	0	0
Docosadienoic C22:2	0.9 ± 0.5	0.9	0	0
Eicosapentaenoic				
C20:5n3, EPA	4 ± 2.1	4	0	0
Docosahexaenoic				
C22:6n3, DHA	1.7 ± 1.4	1.8	0	0

In the present study, the fat and liver oils of *Uromastyx* have more or less same contents of total fatty acids, but the percentage of SFA was much varied (49.6% and 24.5%). The range SFA was found to be (33% - 37.7%) in *Uromastyx* the meat (Abu-Tarboush et al., 1996_b) a range between the liver and fat oil of this lizard. The content of SFA in fat oil was within the range in reported in muscle of beef and cow (47.9% and 55.1%), but too lower than the (70.5% and 86.3%) reported in fat oil of fresh water (Mohamed, 2013). As for liver oil the percentage of SFA was also but too lower than (57.5% -65.5%) liver oil of fresh water fish (Mohamed and Al-Sabahi, 2013). In cod liver oil, SFA% was (17.3%) and in Atlantic herring oil and Menhaden oil, it was (21.5% and 33.3%), respectively (New, 1987). Palmitic acid was the most abundant SFA in the both fat and liver oils and myristic and tricosanoic acids

are the second dominants with higher levels in the fat compared to liver oil. Abu-Tarboush et al. (1996_b) recorded that palmitic acid and stearic acids are the predominant SFA in the meat of *Uromastyx* lizard. In the present study, low content of stearic acid was found in both oils. Palmitic acid was the most abundant SFA in liver, muscle and fat oils of fresh water fish, and myristic, heptadecanoic, stearic and tricosanoic acids were the second major SFA (Mohamed, 2013; Mohamed and Al-Sabahi, 2013).

Table 2. The contents (mg/g \pm SD) and profile (% TFA) of different groups of fatty acids in fat and liver oils of *Uromastyx* lizard

Fatty acid groups	FAT		LIVER	
	mg/g	%	mg/g	%
TFA	100.3	100	101.6	100
SFA	49.8 \pm 6.2	49.6	24.9 \pm 3.6	24.5
MUFA	22.7 \pm 3.8	22.7	41.6 \pm 4.2	41
PUFA	27.8 \pm 3.1	27.7	35.1 \pm 1.6	34.5
UFA	50.5 \pm 3.5	50.4	76.7 \pm 2.4	75.5
N-3	13.3 \pm 1.5	13.2	13 \pm 1.8	12.7
N-6	12 \pm 1.6	12	22.2 \pm 1.4	22
N-3/N-6		1.1		0.6

The unsaturated fatty acid content found in oils from fat and liver was, respectively, (50.4% and 75.5%), where palmitoleic, oleic and eicosenoic were the most abundant MUFA and linolenic acid was the dominant PUFA. Abu-Tarboush et al. (1996_b) reported (62.3-67%) of USFA in the meat of *Uromastyx* lizard, with high percentage of oleic acid (22.7-26.6%) and

lenolenic acid dominated the PUFAs. The content of lenolenic acid in the fat oil was lower than the content reported by Abu-Tarboush et al. (1996_b) but almost same to results obtained by Paul and Southgate (1993) in cow and beef meats. In the liver oil the content of this essential fatty acid was almost double the content in the meat of the lizard and more than five folds the content in meat of cow and beef. Appreciable levels of palmitoleic and ecosenoic acids were detected in both fat and liver oils, where the content in liver oil was doubled that in fat oil. Oleic and palmitoleic acids were also found to be the prominent MUFAs in muscle tissues and elaidic acid was the prominent in fat tissues of fresh water fish, while oleic acid was the dominant MUFA in the liver oil (Mohamed, 2013; Mohamed and Al-Sabahi, 2013).and lenolenic and Lenolenic acids predominate the PUFAs. The UFA/SFA ratio as recommended by nutritionists is 3; in the fat and liver oils of the lizard this ratio was, respectively, 1.0 and 3.1.

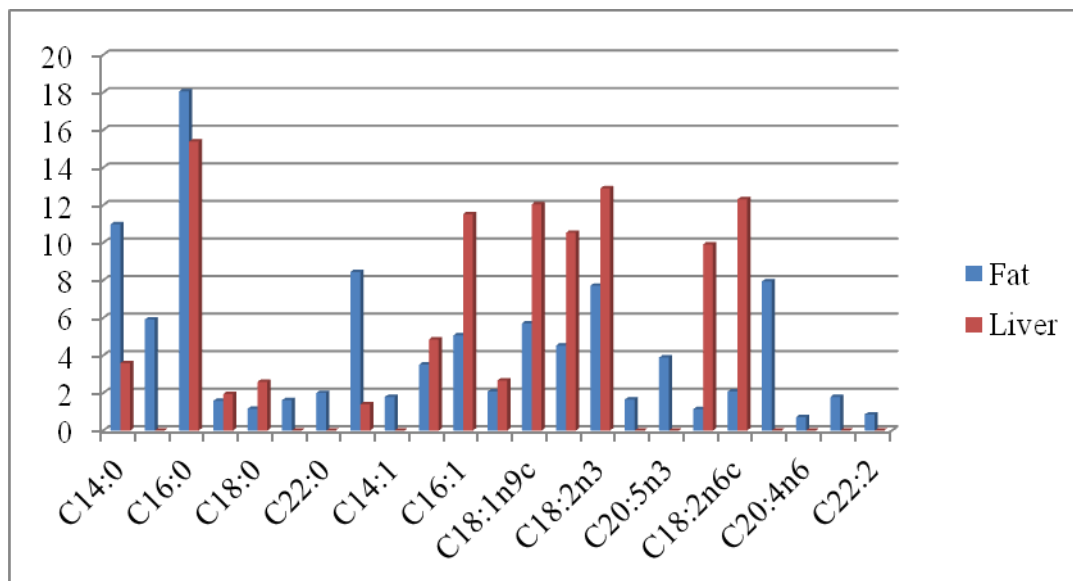


Figure 1. Major fatty acids contents in the fat and liver oils of *Uromastyx* lizard.

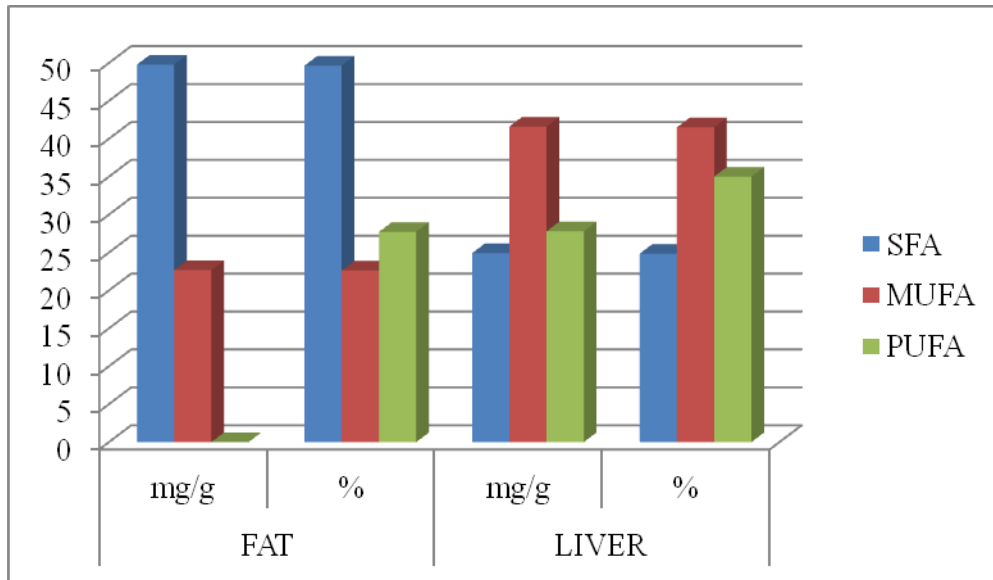


Figure 2. The contents (mg/g) and profile (%) of the major groups of fatty acids in the fat and liver oils of *Uromastyx* lizard.

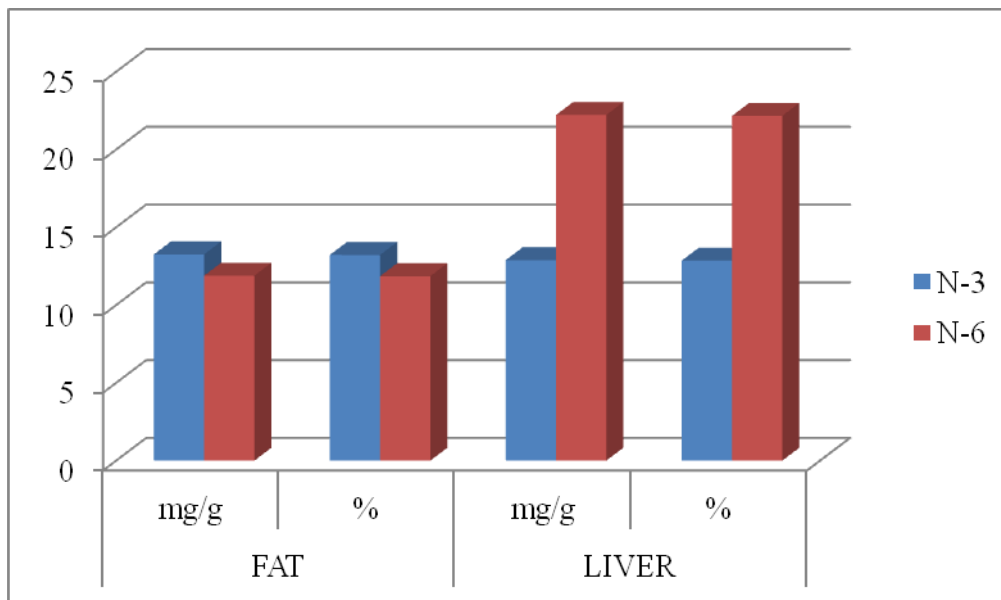


Figure 3. The contents of n-3 and n-6 fatty acids (mg/g) and (%) in fat and liver oils of *Uromastyx* lizard.

The n-6 PUFA vary considerably in the fat and liver oil, where the percentage in the liver was almost two fold that in the fat oil. (N-6 + N-3) together formed (25.2%) in the fat oil and (34.7%) in the liver oil. This indicated that the fat and liver oils of *Uromastyx* contain good levels of Omega-3 (n-3) and Omega-6 (n-6) polyunsaturated fatty acids (PUFA). These fatty acids are recognized to be essential components of humans' diet and play vital roles in disease prevention and health promotion (Connor, 2000; Nordøy et al., 2001; Innis, 2004, Shahidi and Miraliakbari, 2004, Given, et al., 2006.). A balanced n-3/n-6 fatty acids ratio in the diet is known recently as essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery disease, diabetes, hypertension and cancer (Dewailly, et al. 2001; Harris, W.S. 2004; Kalyoncu et al., 2009). The n-3/n-6 ratio in dietary recommendations is (0.2) whereas the in the present study the ratio was (1.1) in fat oil and (0.6) in the liver oil.

The overall significance of this study had been its revelation that *Uromastyx* fat and liver oils have appreciable fatty acid composition and are good sources of ω -3 and ω -6 EFA. More studies especially of the vitamins and mineral contents of *Uromastyx* lizard need to be conducted to evaluate the nutritional quality of its different organs for human diet and other health uses.

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