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Research Article

Fatty acids contents of the edible migratory locust *Locusta migratoria,* Linnaeus, 1758 (Orthoptera: Acrididae)

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ABSTRACT

Fatty acids composition (mg/g) and profile (%) and the major groups of fatty acids of the migratory locust *Locusta migratoria* were determined. Twenty-five fatty acids with various chain lengths and saturation levels have been identified. The most abundant saturated fatty acids were the Palmitic acid, 16:0 (29.5%TFA) followed by Stearic acid, 18:0 (7.3%TFA), while Oleic acid, C18:1n9c (38%TFA) was the major monounsaturated fatty acids, and Linolenic acid, C18:3n3 (11.7%TFA) was the most abundant polyunsaturated fatty acid. The content of saturated fatty acid (SFA) was (84.2 mg/g), while the content of unsaturated fatty acids (USFA) was (121.1 mg/g) forming 59%TFA, the content of polyunsaturated fatty acids (PUFA) was (36.6 mg/g) and monounsaturated fatty acids (MUFA) was (84.5mg/g). (MUFA) are the most predominant fatty acid found in locust tissues and accounted for (41.2%TFA), followed by (SFA) that accounted for (41%TFA) and (PUFA) that accounted for (17.8%TFA). The proportion of saturated/unsaturated fatty acids was (0.7). The content of omega-6 was (11.5mg/g) and omega-3 was (24.8mg/g), accounted for (5.6%TFA) and (12.1%TFA). The ratio of N-3/N-6 was (2.2). Migratory locust meal (*Locusta migratoria*) could be considered as a good nutritional source for fatty acids especially Oleic, Palmitic and linolenic acids.

Keywords: Fatty acid content determination, Edible migratory locust, PUFA, MUFA and TFA.

INTRODUCTION

Edible insects are important traditional food components in different parts of the world[1,2,3]. Orthoptera, and particularly locusts, are commonly raised to feed pets and zoo animals and have been investigated for livestock feeding[4]. The availability of large quantities of dead locusts resulting from locust outbreaks make them a good potential feed for livestock, especially poultry. The development of aquaculture in Africa and Asia, and the search of alternative sources of protein, led to feeding trials of locusts and grasshoppers for catfish and tilapia[5]. Many studies have shown that edible insects contain appreciable amounts of nutritional sources such as proteins, high fiber, fat, vitamins and minerals, especially Iron and Zinc[6,7,8]. These edible insects even contain more healthy polyunsaturated fat than fish or fowl[9], where 100 grams of dried fly was found to contain 54 grams of protein, almost 50 milligrams of iron and good quantities of essential amino acids and B vitamins[10]. Extensive analyses of the nutritional composition of many insects have been published, but comprehensive analysis including amino acids, vitamins, and fatty acids of many insect species is rare[11,12]. Most of the attention on insects as a food source has focused on their high protein content although essential fatty acids, which include linoleic acid (18:2w6) and a-linolenic acid (18:3w3) were found to serve several physiological functions in vertebrates[13,14,15].

In addition to the determined nutritional value of the edible migratory locust *Locusta migratoria* in Sudan[16], the present study was designed to determine the composition and profile of fatty acids and their dietary value compared to other animals. The study also aimed to provide complete valuable information concerning the nutrient intake of captive species fed these insects, and a valuable baseline of insects consumed by humans.

MATERIAL AND METHODS

Sample collection

The migratory locusts, *Locusta migratoria*, was purchased from the traditional market in Khartoum. The insects were crushed and grinded to powder and used to extract lipids and determine the composition and profile of fatty acids in locust tissues.

Fatty acid analysis

Lipid extraction from 10g samples was done using the procedure of Folch et al[17]. 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 study of Ahlgren G and identified by comparing their retention time with those of several commercial standard mixtures (Supelco, USA)[18]. The concentration of individual fatty acid and different groups of fatty acids was calculated using Heneicosanoic acid (C21:0) as internal standard and the result was expressed in mg/g dry weight and (%)/TFA.

RESULTS

Tables (1) represents the fatty acids composition and profile and Table (2) represents the major groups of fatty acids in the migratory locust. Twenty-five fatty acids with various chain lengths and saturation levels have been identified. The most abundant saturated fatty acids was the Palmitic acid, 16:0 (29.5%TFA) followed by Stearic acid, 18:0 (7.3%TFA), while Oleic acid, C18:1n9c (38%TFA) was the major monounsaturated fatty acid and Linolenic acid, C18:3n3 (11.7%TFA) was the most abundant polyunsaturated fatty acid. The content of saturated fatty acids (SFA) was (84.2 mg/g) (Figure 1), while the content of unsaturated fatty acids (USFA) was (121.1 mg/g) forming 59%TFA, the content of polyunsaturated fatty acids (PUFA) was (36.6 mg/g) and monounsaturated fatty acids (MUFA) was (84.5mg/g). As shown in (Figure 2), (MUFA) are the most predominant fatty acid found in locust tissues accounted for (41.2%TFA), followed by (SFA) accounted for (41%TFA) and (PUFA) accounted for (17.8%TFA). The proportion of saturated/unsaturated fatty acids was (0.7). The content of omega-6 was (11.5mg/g) and omega-3 was (24.8mg/g), accounted for (5.6%TFA) and (12.1%TFA). The ratio of N-3/N-6 was (2.2).

DISCUSSION

Arachidonic acid was detected in the migratory locust, *Locusta migratoria*[14] and the cricket *Acheta domesticus*, and Lauric acid was reported as the dominant fatty acid in soldier fly larvae[19]. These acids has not been detected in migratory locust used in the present study. The dominant fatty acid in the migratory locust was Oleic, Palmitic, Linolenic and Stearic acids, which are similar to the patterns observed for house flies, Turkestan cockroaches, mealworms, superworms, waxworms, crickets and tebo worms. The phospholipid fatty acid composition of the adult *T. molitor* was analyzed and over 80 percent of these fatty acids consisted of Palmitic, Stearic, Oleic and Linoleic acids[7]. Same fatty acids were found in high amounts in *T. molitor* larvae.

The present results were also consistent with Finke et al, who found that polyunsaturated fatty acids(PUFA) were the most predominant fatty acids found in four species of feeder insects, followed by saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA)[15]. Polyunsaturated fatty acids (PUFA) were the most predominant fatty acids found in eight analyzed insects, followed by saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA).In a study of migratory desert locust, *Locusta migratoria* (Orthoptera: Acrididae), found in the alpine grasslands in China, the percent of unsaturated fatty acids in total fat was found to range from 75.3–79.7%: linolenic acid was (25–30.3%) and oleic acid was (26.6–30.1%).

The functions of fatty acids that are essential to vertebrates apply also to insects. Since insects are poikilotherins the degree of unsaturation of the fatty acids associated with the phospholipids is very important for fluidity of the membranes. The present results and those of previous studies, show that insect fatty acids have very high ratio of the polyunsaturated[6,19] , but had not reported consistent pattern for fatty acids profiles of a variety of insect species. According to Ahlgren et al, insect fatty acid patterns appear to largely reflect the fatty acid composition of the insect's food[18]. Although the nutritional values of edible insects are highly different among various species[8,20,21,22,23] and in same group at different metamorphic stages of the insect and its habitat and diet[24,25,26,27], however, a meal of migratory locust (*Locusta migratoria*) could be used for fish in aquaculture and for captive insectivores as well as humans[12,15].

CONCLUSION

Depending on the present study and previous results, it can be concluded that migratory locust meal (*Locusta migratoria*) could be used as food and feed for both fish in aquaculture, poutry and captive insectivores as well as humans. Data of the present study are valuable in assessing the nutrient intake of migratory locust. Investigation of other nutrients such as vitamins could add more importance of migaratory locust as food and feed.

Table 1
Fatty acids composition (mg/g) and profile (%) in the migratory locust, *Locusta migratoria*.

Fatty acid	mg/g	%
Caproic acid (C6:0)	0.76	0.37
Capric acid (C10:0)	0.24	0.12
Lauric acid (C12:0)	0.23	0.11
Tridecanoic acid (C13:0)	0.18	0.09
Myristic acid (C14:0)	3.89	1. 90
Pentadecanoic acid (C15:0)	0.22	0.11
Palmitic acid (C16:0)	60.61	29.52
Palmitoleic acid (C16:1)	2.31	1.13
Heptadecanoic acid (C17:0)	1.13	0.55
Cis-10-heptadecanoic acid (C17:1)	0.22	0.11
Stearic acid (C18:0)	15.06	7.33
Elaidic acid (C18:1n9t)	3.74	1.82
Oleic acid ME (C18:1n9c)	78.02	38
Linolelaidic acid (C18:2n6t	0.51	0.25
Linoleic acid (C18:2n6c)	10.76	5.24
Arachidic acid (C20:0)	0.94	0.46
Linolenic acid (C18:3n6)	0.22	0.11
Cis-eicosenoic acid (C20:1)	0.21	0.1
Linolenic acid (C18:3n3)	24.01	11.69
Cis-eicosadienoic acid (C20:2)	0.32	0.16
Behenic acid (C22:0)	0.21	0.1
Eicosatrienoic C20:3n3	0.55	0.27
Tricosanoic acid (C23:0)	0.55	0.27
Lignoceric acid (C24:0)	0.19	0.09
Docosahexaenoic C22:6n3 (DHA)	0.24	0.12
Sum	205.32	100

Table 2
The major groups of fatty acids in the migratory locust, *Locusta migratoria*.

Fatty acids groups	mg/g	%
SFA	84.2	41
MUFA	84.5	41.2
PUFA	36.6	17.8
USFA	121.1	59
SFA / USFA	0.7	
Omega - 6 (N-6)	11.5	5.6
Omega - 3 (N-3)	24.8	12.1
N-6 / N-3	0.5	
N-3/N-6	2.2	

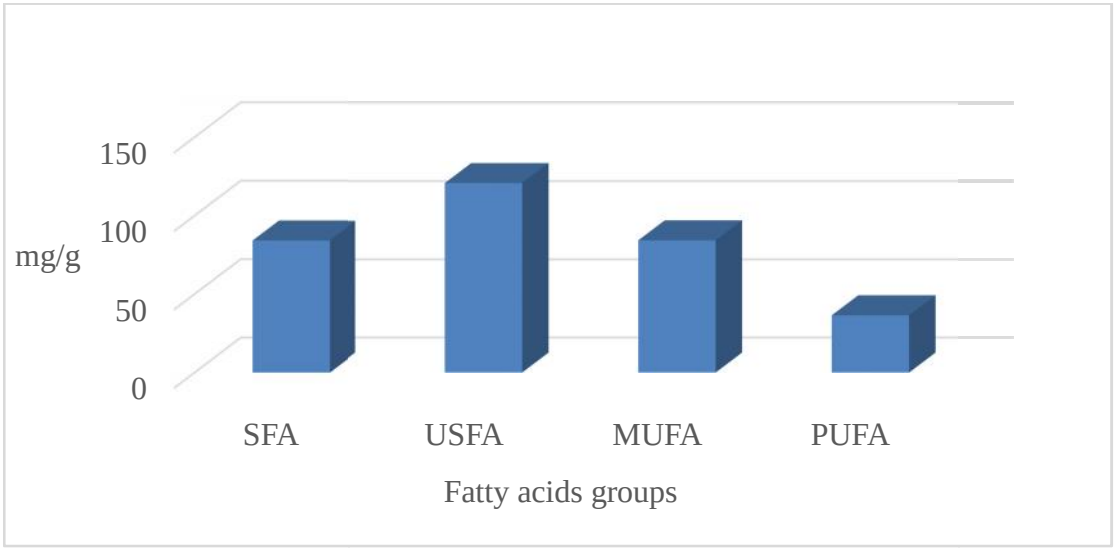

Figure 1
The contents (mg/g) of major groups of fatty acids in the migratory locust, *Locusta migratoria*.

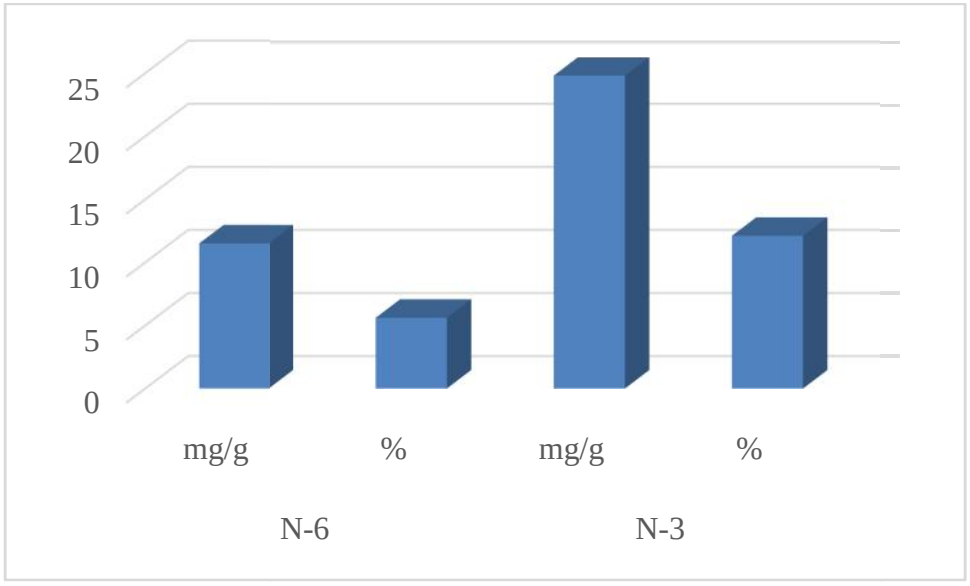

Figure 2
The contents (mg/g) and percentage (%TFA) of omega-3 and omega-6 fatty acids in the migratory locust, *Locusta migratoria*.

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