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Research Article

**Determination of Nutritive Value of the Edible
migratory locust *Locusta migratoria*, Linnaeus, 1758
(Orthoptera: Acrididae)**

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ABSTRACT

The study was conducted to determine the nutritional composition of the migratory locust *Locusta migratoria* (Orthoptera: Acrididae), commonly eaten by people in Sudan, in order to provide basis for using locust as food for humans or feeds for animals. Proximate analyses indicated the presence of (96.19 ± 0.2) dry matter in 100g. Crude protein was (50.42 ± 2 %), crude fat (19.62 ± 0.8 %), carbohydrates (4.78 ± 0.74 %), crude fiber (15.65 ± 1.7 %), ash (6.24 ± 0.5 %) and moisture content was (3.81 ± 0.2 %). Energy content was (490.4 ± 4) calories in 100g of dry product. The ratio of crude fat: crude protein (CF:CP) was 0.39, carbohydrates: crude protein (CH:CP) was 0.09, carbohydrates: crude fat (CH:CF) was 0.24. Minerals content was very low except for phosphorus, which has an average value of (29.6 ± 4.32 ppm), while other minerals have a range of (0.04 to 2.2 ppm). The results indicated high nutritional value of the migratory locust, and could be considered as a good food source for both humans and animals, especially for protein, fat, phosphorus and energy. It is recommended that hygienic practices should be applied in collecting and cooking of these insects and spreading by insecticides should be avoided. More investigation of the nutritive values such amino and fatty acids, vitamins and minerals should be carried out to evaluate the migratory locust.

Keywords: Energy, fat, migratory locust, nutritional value, phosphorus, protein.

INTRODUCTION

Locusts, grasshoppers crickets and katydids are consumed worldwide for human food in Africa, South America and Asia, both in rural and urban areas^{1,2}. Commercial farming of locusts, grasshopper and crickets is developing for food and feed in South East Asia and rice field grasshoppers are harvested for food in Japan, China and Korea³. In Mexico, the grasshoppers *Sphenarium purpurascens*, a pest of alfalfa, are popular edible insects⁴. In Africa, the desert locust (*Schistocerca gregaria*), the migratory locust (*Locusta migratoria*), the red locust (*Nomadacris septemfasciata*) and the brown locust (*Locustana pardalina*) are commonly eaten. They are important food source, as are other insects, adding proteins and fats to the daily diet, especially in times of food crisis. However, in many African, Middle Eastern and Asian countries, locusts are considered a delicacy and eaten in abundance. They are also served on skewers in some Chinese food markets.

Since the 2000s, the development of aquaculture in Africa and Asia and the search of alternative sources of protein had led to feeding trials of locusts and grasshoppers for catfish and tilapia. The nutritional qualities of edible insects have been studied by various authors including^{5,6,7,8,9}. Locust are considered edible and regarded for their high content of protein, dry matter, minerals and vitamins^{10,11}. The migratory locust form swarms consisting of huge numbers and can travel great distances, causing considerable damage to crops^{1,2}. However, in Sudan, locusts are eaten and prepared in numerous ways, boiled, fried or sun-dried and eaten raw. Therefore, present study was conducted to determine the nutritional composition of raw migratory desert locust, *Locusta migratoria* (Orthoptera: Acrididae), in order to determine its nutritive value and provide basis for using locust as human food and animal feeds.

MATERIAL AND METHODS

Samples of the migratory locust, *Locusta migratoria* were purchased from the Central Market in Khartoum and oven-dried at 45°C according to the procedure described by¹². Dried samples were crushed and grinded to powder and used for proximate analysis. The contents of dry matter, crude protein, carbohydrates, fibre, ash and moisture were determined by the method of the Association of Official Analytical Chemists¹³. The concentration of mineral elements was determined using Atomic Absorption Spectrophotometer (AAS) and calculated in ppm ($\mu\text{g/g}$ dry weight). Each analysis was carried out in triplicates and expressed as percentage (mean \pm standard deviation, SD) in 100g of dry insects. Energy content was calculated and expressed as calories/100g.

RESULTS AND DISCUSSION

Proximate analysis for the edible migratory locust (Table 1 and Figure 1) revealed a range of (94.18 – 98.20 %) dry matter with average value of (96.2%). The range of crude protein was (42.16 – 58.62%) with average of (50.42%), crude fat ranged between (18.9 and 20.34%) with average of (19.62%) while carbohydrates formed average value of (4.78%) and range of (4.05 - 5.51%). Fiber content was (14.21 - 17.09 %) with average value of (15.65%), ash range was (5.72 - 6.76%) with average value of (6.24%) and average content of moisture was (3.8%) with a range of (2.9 - 4.7%). The range of calories in the migratory locust was (480.3 - 500.3 cal/100g) with average of (490.8 cal/100g). Minerals content was very low except for phosphorus (Table 2), which ranged between (26.5 to 32.6 ppm) with an average value of (29.6 ± 4.32 ppm), while other minerals (Figure 2) have a range of (0.04 to 2.2 ppm).

Table 1
Proximate composition (%100g) and caloric value (cal/100g) of the dry migratory locust *Locusta migratoria*.

Parameters	Range (%)	Mean \pm DS (%)
Dry Matter	94.18 - 98.20	96.19 \pm 0.2
Crude protein	42.16 - 58.62	50.42 \pm 2
Crude Fat	18.9 - 20.34	19.62 \pm 0.8
Carbohydrates	4.05 - 5.51	4.78 \pm 0.74
Fiber	14.21 - 17.09	15.65 \pm 1.7
Ash	5.72 - 6.76	6.24 \pm 0.5
Moisture	2.9 - 4.7	3.81 \pm 0.2
CF:CP	0.39	0.39
CH:CP	0.09	0.09
CH:CF	0.24	0.24
Caloric value (cal/100g)	480.3 - 500.3	490.4 \pm 4

Table 2
Mineral contents in tissues (p.p.m) of dry migratory locust *Locusta migratoria*

	P	Ba	Zn	Fe	Al	B	Pb	Cr	Co	Mn
Average	29.58	2.192	0.879	0.554	0.443	0.298	0.213	0.060	0.060	0.040
SD	4.32	0.36	0.09	0.03	0.01	0.06	0.09	0.01	0.01	0.01

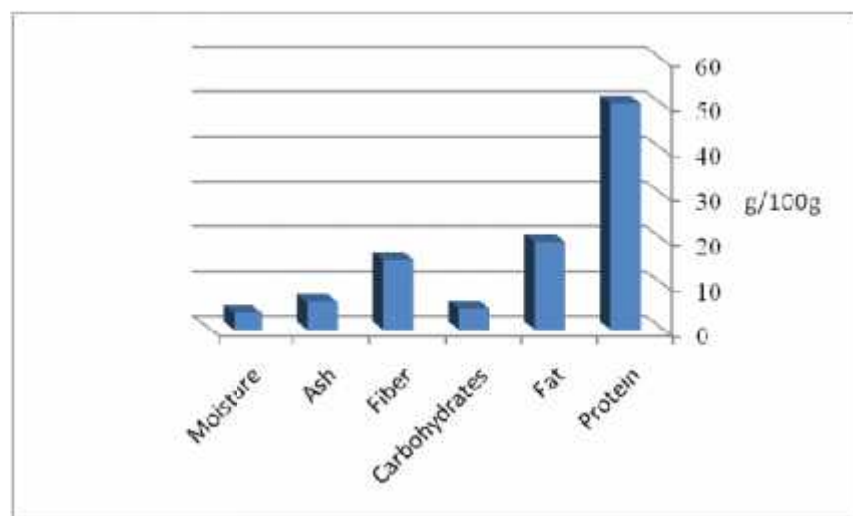


Figure 1
Nutrients contents (%) in the dry product of the migratory locust *Locusta migratoria*.

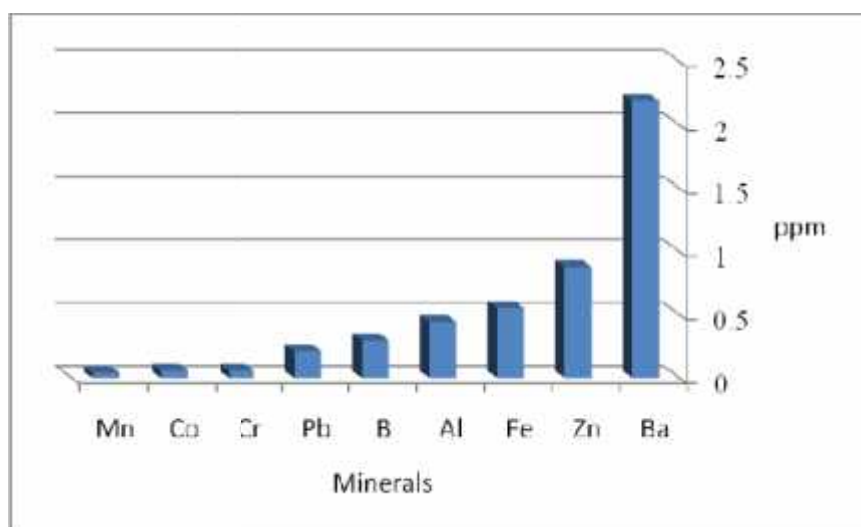


Figure 2
Minerals content (ppm) of the dry migratory locust *Locusta migratoria*.

The present results indicated that the edible migratory locust contains appreciable quantity of dry matter and protein as other insects¹⁴. Above 50% crude protein content was reported in 40 insect species on a dry matter basis⁵ and it ranged as high as 82%. Locusts and other Orthoptera species are generally rich in protein where a range of 50-65% /DM was reported, though some lower values (<30%) have also been reported¹¹. Protein content of insects was found to range from 37% in queen caste to 54% in dung beetle and lipid contents ranged from 5% in June beetle to

37% in queen caste¹. Over 60% of dry matter of an edible caterpillar was found to protein¹⁵. It was further estimated that the consumption of 100 g of caterpillars by humans, provides about 76% of daily protein requirements and almost 100% of vitamins¹⁶. Crude fat is the second major component of the migratory locust ensuring its importance as fat source. The values obtained were within the range reported of whole edible insects, from 2.2% of *Nasutitermes corniger* (Motschulsky) worker termites, to 60% of greater wax moth *Galleria*

mellonella (L.) larvae^{14,17,18,19}. Carbohydrate levels are very low in locusts. The highest amount of carbohydrate (16%) was found in cicada, while ash contents of edible insects ranged from 2% in queen caste to 12% in June beetle. High amount of fibre but low moisture content were found in the migratory locust. Moisture content is an index of water activity²⁰ and susceptibility to microbial contamination²¹. Consequently, the low percentage moisture value obtained indicated that the migratory locust can be stored for a reasonable period of time without the risk of microbial deterioration and spoilage if properly dehydrated. As expected, the migratory locusts like most insects, contain only small amounts of ash because they lack the internal calcified skeleton found in most vertebrates. It is also reported that soft-bodied insects contain less fiber than those with a hard exoskeleton.

High phosphorus levels but low levels of trace minerals of barium, zinc, iron, copper, aluminum, manganese and boron have been reported in the migratory locust. Insects were found to contain high levels of phosphorus, which results in a calcium:phosphorus ratio of less than one. However, most insects contain substantial levels of macro-minerals, magnesium, sodium, potassium and chloride and appear to be good sources of the trace minerals of iron, zinc, copper, manganese and selenium. Mineral composition of insect could vary with variation in food sources, seasons and different populations of the same species living in the same general area. However, the quantity of crude protein, crude lipid and calories present in edible migratory locust are comparable to those of beef, fish, lamb, chicken, milk and eggs^{7,22}. The dry matter content is 23-35%. The fat content is quite variable and ranges from relatively low values (<5%) to high ones (>20%). The "fibre" content may be significant and increases with age: adult crickets contain up to 22% DM and nymphs contain 12%. The ratio of fat : protein (F:P) was low, as a result of the high proportion of crude protein. Fat content is known to be inversely related to crude protein²³. Energy content of the migratory locust was higher than 247cal/100 grams content recorded for the locust Tsukudani. The results indicated that the migratory locust could be considered as a good nutritional food source especially for protein and fat as well as a potential source of energy. The diversity and large number of insect species inhabiting different environments mean that insects are important food sources for many terrestrial and aquatic animals. Therefore, nutrient analysis of minerals, vitamins, amino acids and fatty acids of fresh locust and other edible insects can help evaluate the nutrient intake of human and wild animals^{24,25,26}.

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