NUTRITIONAL POTENTIAL OF LONGHORN GRASSHOPPER (*RUSPOLIA DIFFERENS*) CONSUMED IN SIAYA DISTRICT, KENYA

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ABSTRACT

The longhorn grasshopper (*Ruspolia differens*) forms a major part of the food culture of communities in the Lake Victoria Region of East Africa. The aim of this research was therefore to assess the nutritional potential of this insect to the human diet in the region in combating nutritional deficiencies that are of public health concern. The green and brown coloured grasshoppers were studied. They were found to contain a protein content of 37.1% and 35.3%, fat content of 48.2% and 46.2%, ash content of 2.8% and 2.6%, a fibre content of 3.9% and 4.9% for the green and brown grasshoppers respectively. Among the macro minerals, potassium (K) was the most abundant with a value of 370.6 mg/100g and 259.7 mg/100g, phosphorus (P) 140.9 mg/100g and 121.0 mg/100g while calcium (Ca) levels showed overall means of 27.4 mg/100g and 24.5 mg/100g in the green and brown grasshopper respectively. Iron (Fe) was the most abundant among the trace minerals with a value of 16.6 mg/100g and 13.0 mg/100g while zinc showed a mean value of 17.3 mg/100g and 12.4 mg/100g in the green and brown grasshopper respectively. The insects showed a retinol concentration of 2.1 µg/g and 2.8 µg/g, α-tocopherol 201.0 µg/g and 152.0 µg/g, riboflavin 1.2 mg/100g and 1.4 mg/100g, 2.1 mg/100g and 2.4 mg/100g of niacin for the green and brown grasshopper respectively. Lipid analysis revealed that the insects' oil comprised of high amounts of polyunsaturated fatty acids, 89.4% and 84.3% neutral lipids, 7.4% and 9.3% phospholipids, 3.2% and 6.4% glycolipids for green and brown grasshopper respectively. These values suggest that *Ruspolia differens* has potential for exploitation to combat nutritional deficiencies that are of public health concerns. The insect could form a base for new food products of considerable nutritive value.

Key words: Nutritional potential, *Ruspolia differens,* longhorn grasshopper, public health

1.0 INTRODUCTION

Insects have played an important part in the history of human nutrition in Africa. There are more than 400 known species of edible insects (Allotey and Mpuchane*,* 2003). In Africa, many species of insects have been used as traditional foods among various communities. Insects were an equally important resource for the Indians of western North America who, like other indigenous groups, expended much organisation and effort in harvesting them (Sutton, 1988).

The longhorn grasshopper (*Ruspolia differens*) has been a part of the food culture in the Lake Victoria region of East Africa. It is locally known as *nsenene* or *senesene* across the region. During certain times of the year, usually after the first rains following a dry season, the grasshoppers swarm (Bailey and McRae, 1978). The grasshopper is non-destructive, as it causes no damage to crops and vegetation and this makes them unique from locusts. Most of the swarms concentrated on streetlights in urban areas, on grasses and shrubberies with no apparent damage. They are attracted to light in the evenings and thus are easily collected. During their swarming season children and their parents arm themselves with saucepans, baskets and polythene bags, which they fill with thousands of the insects, which swarm around streetlights every evening.

The longhorn grasshopper expresses colour polymorphism with the green and brown as the most common although as many as six colour forms have been reported (Bailey and McRae, 1978). The grasshoppers may be consumed raw, after the wings have been pulled off. However as the insects are only seasonally available, preservation by sun-drying is often practised. Other traditional processes practised include insects being fried before sun-drying. Similarly, consumption of other species of grasshoppers like the variegated grasshopper, *Zonocerus variegates* (Linn.) has been reported in southwestern Nigeria where it has a large dry season population (Fasoranti and Ajiboye, 1993) as well as in other regions of Africa (Ohiokpehai *et al.*, 1996).

Whether or not insects are eaten depends not only on taste and nutritional value, but also on customs, ethnic preferences or prohibitions (Van, 2003). The harvesting of insects is often done by women. The mode of collection depends on insect behaviour. For example, inactivity at low temperatures enables easy capture of long horn grasshoppers in the morning. A number of tools are used to facilitate capturing such as glue, sticks, nets and baskets.

Ordinarily, insects are not used as emergency food during shortages, but are included as a planned part of the diet throughout the year or when seasonally available (Banjo *et al.,* 2006). Therefore, considering the chronic or seasonal shortage of vertebrate food reserves in sub-Saharan Africa, utilsation of insects as alternative food source on a wide scale should be encouraged. Nutrients useful in the maintenance of human health may be obtained by direct consumption of insects. Food supplies in many countries in Africa are inadequate in quantity and quality, contributing to the widespread malnutrition on the continent (Kent, 2002; Allotey and Mpuchane*,* 2003). Malnutrition continues to kill many children, act as a catalyst in various childhood diseases. It also exacerbates rates of illiteracy and unemployment and impedes overall socio-economic progress in the region (Oniang'o and Mutuku, 2001).

To manage the insects in the interest of food security, they should be made better available throughout the year by inventing organised and controlled production of the insects as mini-livestock and improving the conservation methods. This study was undertaken to determine the nutrient composition of grasshopper (*Ruspolia differens)* as a prerequisite for promoting controlled production, consumption and commercialization of the insect.

2.0 MATERIALS AND METHODS

The information on the insects was acquired through personal observation and informants living in Kanyaboli and Kadenge Sub-location of Siaya District. A total of six villages were visited, namely, Urembo, Uradi, Wang', Chieny, Nyaseda and Liganwa, where a total of twelve families and one adult from each family were selected as an informant. Two types of longhorn grasshoppers, the green and brown colored, were collected. The grasshoppers were available during the time of the fieldwork during the long rain season from September through December. The samples were collected in triplicates in 2007 and a replication done in 2008.

The grasshoppers were collected early in the morning between 6.00 am and 7.00 am when they were inactive and therefore could not fly and put in a clean container. A sample weight of 0.5 kg was collected for each grasshopper. The insects were then put in plastic bags and kept in cool boxes with dry ice and transported to the Food Biochemistry laboratory at Jomo Kenyatta University of Agriculture and Technology, for laboratory analysis which commenced within 12 hours of collection. Similar samples were at the same time sent to the Department of Entomology at Maseno University for taxonomic identification by an entomologist. The non-edible wings of the whole insects were plucked off manually before laboratory analysis. Each analysis was done in triplicates.

Samples were analysed for moisture content, fat, ash, fibre and crude protein (CP) according to the methods of the AOAC (1996). Mineral analysis (Ca, Mg, K, Na, Fe, Zn, Cu, and Mn) was performed by atomic absorption spectrophotometry (Perkin-Elmer model 2380) (AOAC 1996). Phosphorus (P) was determined by the colorimetric method (AOAC, 1996). Retinol and α-tocopherol were analysed by a Shimadzu LC-10A VP Series liquid chromatograph equipped with a 250 x 4.0 mm stainless steel ODS reversed-phase column fitted with a UV-Vis detector as described for insect samples in the method by Barker *et al.* (1998) while the water soluble vitamins were also determined by Shimadzu LC-10A VP Series liquid chromatograph fitted with a photo-diode detector (Waters 2996) as described in the method by Ekinci and Kadakal (2005).

Fatty acid profile analysis was done using gas chromatograph (Shimadzu GC-9A) according to Bligh and Dyer (1959). Fatty acid methyl esters were identified by comparison of retention times with standards and expressed as percentages of total methyl esters. The general fractionation procedure of Rouser *et al.* (1967) as modified by Bozkus (2002) was used for the fractionation of the lipid into neutral lipid, glycolipid and phospholipid fractions. The lipid fractions were prepared from total lipid extracts by separation in a 250cm^3 separation tank after spotting on TLC plates (silica gel 250 µm layer flexible plates) in appropriate solvents and identified by comparison with authentic standards. The intensity of the spots was quantified by densitometry using a flying spot scanning densistometer (Shimadzu CS: 9000) and the values obtained used to give the fraction of the lipid classes. Commercial standards were used in computing the standards for the minerals, vitamins, fatty acids and lipid fractions analyzed (Sigma Chemicals Co, Germany).

Descriptive analysis of the data was done. A two-tailed T-test was used to test the difference between the green and brown grasshopper using SAS statistical analysis software (SAS, 2001).

3.0 RESULTS AND DISCUSSION

The proximate composition of the grasshoppers fresh expressed on dry matter basis is presented in Table 1. There was significant difference between the moisture contents of the fresh green and brown grasshopper at $p \leq 0.05$ (Table 1).

The analysis of ash content indicated an ash value slightly lower than the values indicated for other edible insects such as alates of *Nasutitermes spp.* (3.7%) as reported by Oyarzun *et al.* (1996). The values obtained from the insects were however consistent with the values (2.1 – 6.8%) of other edible insects (Christensen *et al.,* 2006; Mbah and Elekima, 2007).

There was no significant difference between the green and brown grasshoppers ($p > 0.05$) in protein content. Mbah and Elikima (2007) reported a protein content of 38.72% for an adult winged variegated grasshopper, *Zonocerus variegates* and this was comparable to the results obtained in this research.

Table1: Proximate composition of grasshoppers

Analysis	*Ruspolia differens* (Green)	*Ruspolia differens* (Brown)
Moisture content (%)	66.4 ± 0.5^b	71.2 ± 1.0^a
Ash (%)	2.8 ± 0.5^b	2.6 ± 0.4^a
Crude Protein (%)	43.1 ± 0.5^a	44.3 ± 0.7^a
Crude fat (%)	48.2 ± 0.2^a	46.2 ± 0.3^b
Crude fiber (%)	3.9 ± 0.1^a	4.9 ± 0.1^a

*All values except moisture content expressed as means ± SE on dry weight basis.
*Values on the same row followed by the same letter are not significantly different ($p > 0.05$)
n = 6

However, the protein content of the grasshoppers was lower than the values reported for first instar stage (53.10%) and fourth instar stage of variegated grasshopper, *Zonocerus* *variegatus* L. (52.50%) (Adedire and Aiyesanmi, 1999). The insects showed higher protein content in comparison to common lean red meat of different sources (Williams, 2007) who reported 23.2% for beef, 24.8% for veal and 21.5% for mutton. The protein content exhibited by the insects was significantly higher than the conventional animal meats and therefore insects may offer an affordable source of protein to counteract the protein malnutrition in Kenya (Kariuki and White, 1991).

The fat content of the grasshoppers as shown in Table 1 was considerably higher than the fat values reported for other insects studied by Banjo *et al* (2006) for other insect species (19.7 - 24.1%). Insects can offer a high fat content for the human diet among the communities practicing entomophagy. Fat is essential in the human diets because it increases the palatability of foods by absorbing and retaining their flavours (Aiyesanmi and Oguntokun, 1996). Fat is also vital in the structural and biological functioning of cells. However, one implication of the high fat content in the insects is that it may increase susceptibility of the undefatted insect to storage deterioration via lipid oxidation (Ekpo and Onigbinde, 2007).

The grasshoppers showed high fibre content. These fibre fraction values may represent a measure of true fiber values of the grasshoppers' digestive tract contents, as these insects feed on a cellulose and lignin-rich material and they were not fasted before analysis. There is need, however to determine if these fibre is of any dietary significance.

Table 2: Mineral content of the grasshoppers

Mineral (mg/100g)	*Ruspolia differens* (Green)	*Ruspolia differens* (Brown)
Calcium	27.4 ± 0.1[a]	24.5 ± 0.1[b]
Magnesium	33.9 ± 0.1[a]	33.1 ± 0.3[a]
Potassium	370.6 ± 1.0[a]	259.7 ± 1.0[b]
Sodium	358.7 ± 1.0[a]	229.7 ± 1.0[b]
Phosphorous	140.9 ± 1.1[a]	121.0 ± 1.1[b]
Iron	16.6 ± 0.1[a]	13.0 ± 0.2[b]
Zinc	17.3 ± 0.0[a]	12.4 ± 0.0[b]
Manganese	5.3 ± 0.0[a]	2.5 ± 0.0[b]
Copper	0.6 ± 0.0[a]	0.5 ± 0.0[a]

All values expressed as means ± SE on dry weight basis
Values on the same row followed by the same letter are not significantly different ($p > 0.05$)
n = 6

Potassium (K) was the highest by far among the macro minerals (Table 2), with calcium being approximately ten times less than the amount of potassium. This is distinctive from vertebrate species with higher calcium and phosphorous content. But this is logical, as invertebrates have no bony skeletons. The values obtained were consistent with values reported by Oyarzun *et al.*, (1996) for termites but far much higher than what Ekpo and Onigbinde (2005) reported (26.65 mg/100 g) in larva of palm weevil, *Rhynchophorus phoenicis* F. consumed in Nigeria.

There was significant difference in calcium content between the green and brown grasshopper (pd"0.05). The values were significantly high in comparison to some conventional lean meat sources (4.5 mg/100g in beef) as reported by Williams (2007). In general, the calcium in insects has been reported to be relatively low compared to the RDI (FAO/WHO, 2001) for all age categories (Onigbinde and Adamolekun, 1998). Even so, as long as insects are eaten as a supplementation to the main meals, they will still provide an important additional calcium source. But other means of supplementing the traditional diets with calcium in many African communities are important as well, since calcium deficiency and even rickets is a problem in Africa (Bwibo and Neumann, 2003).

The green grasshopper recorded a higher phosphorous value than the brown grasshopper (Table 2). There was significant difference (pd"0.05) between the green and brown grasshopper, though the content of both was comparable to conventional meat sources (Williams, 2007). Unlike plant-based phytate phosphorus, the phosphorus in insects is likely to be readily available, as was shown for facefly pupa (Dashefsky *et al.*, 1976; Finke, 2002).

Iron was consistently the highest mineral of the trace minerals among the insects (Table 2) with the values obtained being significantly different ($p \leq 0.05$) between the two grasshoppers. The values observed in this study were, however, lower than the results reported by Oyarzun *et al.,* (1996) (24.6 mg/100g) for *Nasutitermes spp.* of edible termites. The results show that the insects are a better source of iron in comparison to the mainly available sources with values of 1.1-3.3 mg/100g of iron in a variety of red meats (Williams, 2007).

The concentrations of zinc (17.3 and 12.4 mg/100g) obtained were comparable to the values reported by Christensen *et al.,* 1996 (8.1 – 14.3 mg/100g) from insects consumed by the *Luo* community from Bondo District of Kenya. The values were found to be higher than the values reported for conventional red meats (3.9-4.6 mg/100 g) as reported by Williams (2007).

In general, mineral composition probably largely reflects the food sources of the insect. Studies of wild insects show both seasonal variation and variations between different populations of the same species living in the same general area (Finke, 1984). This may explain the difference between the green and brown grasshopper in mineral contents.

The levels of minerals present in the insects indicate that they are good sources of minerals for young, pregnant and lactating mothers. Iron and zinc deficiency is widespread in developing countries, especially in children and women of reproductive age (Christensen *et al.,* 2006). Iron deficiency leads to anaemia, reduced physical activity and increased maternal morbidity and mortality (Hallberg *et al.,* 2000). Zinc deficiency causes impaired growth and contributes considerably to the high infectious disease burden (Walker and Black, 2004). Zinc deficiency has also been known to cause poor growth and impairment of sexual development (Chaney, 1997). Vegetarians are at risk of zinc deficiency (Ekpo and Onigbinde, 2005). The cereal based diets for feeding infants and young children observed in most third world countries could receive a boost with the addition of the insects to the diets.

There was variability in the vitamin content of the two grasshoppers (Table 3). The retinol content reported for grasshoppers (2.1 µg/g, 2.8 µg/g) is equivalent to 707.2 IU and 923.0 IU for green and brown grasshoppers, respectively (conversion factors: 0.3 µg retinol = 1 IU) (Barker *et al.*, 1998). These insects have the potential to contribute significantly to the daily Vitamin A requirements for infants, adult female and lactating females (1249 IU, 2664 IU and 4329 IU respectively) [National Research Council, 1989]. They can be a good source of retinol to supplement the widely consumed plant food sources.

Vitamin E has different isomers but α-tocopherol is the only isomer that has 100% Vitamin E activity. The grasshoppers had high values of α-tocopherol 201.0 µg/g and 152.0 µg/g for the green and brown grasshoppers, respectively (Table 3). These values were comparable to the values reported for red meats (Williams, 2007).

Table 3: Vitamin content in grasshopper

Vitamin	*Ruspolia differens* (Green)	*Ruspolia differens* (Brown)
Retinol (µg/g)	2.1 ± 1.0^{a}	2.8 ± 0.4^{a}
α-tocopherol (µg/g)	201.0 ± 0.4^{a}	152.0 ± 0.1^{b}
Niacin (mg/100g)	2.1 ± 0.0^{b}	2.4 ± 0.8^{a}
Riboflavin (mg/100g)	1.2 ± 0.2^{a}	1.4 ± 0.6^{a}
Ascorbic acid (mg/100g)	0.1 ± 0.0^{a}	0.1 ± 0.1^{a}
Folic acid (mg/100g)	0.9 ± 0.4^{a}	0.9 ± 0.0^{a}
Pyridoxine (mg/100g)	0.4 ± 0.0^{a}	0.2 ± 0.1^{b}
Thiamin (mg/100g)	nd	nd

nd - Not detected
All values as means ± SE on dry weight basis
Values on the same row followed by the same letter are not significantly different ($p > 0.05$)
n = 6

The α-tocopherol reported is equivalent to 29.95 IU and 22.64 IU for the green and brown grasshopper, respectively (conversion factors: 1mg α-tocopherol = 1.49 IU) (Barker *et al.*, 1998). The grasshoppers therefore have the potential to contribute significantly to the RDI for humans, which range from 50 IU to 100 IU (National Research Council, 1989). Vitamin E is an essential nutrient that is functional as an antioxidant in the body. It helps in reducing the amount of radicals in the body by scavenging for them. Lipids in the body are vulnerable to oxidation and vitamin E protects the various lipids including the phospholipids (Burton and Ingold 1986).

Among the water-soluble vitamins (Table 3), niacin content was highest in the brown grasshoppers (2.4 mg/100g) while the green grasshopper had a lower value (2.1 mg/100g). The results obtained were comparable to the values reported for other insects which included adult crickets (3.84 mg/100 g), mealworm larvae (4.07 mg/100 g) as reported by Finke (2002). In addition, Rao (1994) reported that dried silkworm pupae contained 1.17 mg/100g. Williams (2007) reported a 5.0 mg/100 g of niacin in beef, showing that the insects provided half the amount of niacin as most red meats. Niacin is an important component of the diet since it forms (NAD) and Nicotinamide Adenine Dinucleotide Phosphate (NADP), which are important co-enzymes in energy metabolism. It also plays a role in fat synthesis and fat breakdown (McClenahan and Driskell, 2000)

The observed riboflavin content of green and brown grasshoppers (Table 3) were higher than for most of the insects reported by Finke (2002) which had less than 1.0 mg/100 g in mealworm, wax worm, silk worm except adult cricket which was shown to contain 3.4 mg/100 g of riboflavin. Red meat was found to contain a riboflavin content of 0.18-0.22 mg/100 g (Williams, 2007).

Oyarzun *et al.* (1996) reported that no detectable amounts of ascorbic acid were found in *Nasutitermes spp* of termite collected in Venezuela. Finke (2002) reported a varied ascorbic acid content ranging from less than 1.0 mg/100g in silkworm to 5.4 mg/100 g in adult mealworm. Banjo e*t al.* (2006) reported a comparable ascorbic acid content of 3.41 mg/100 g and 3.01 mg/100 g for *Macrotermes bellicosus* and *Macrotermes notallensis* termites respectively. These values were much higher than the amounts reported for grasshoppers in this research. This could however be attributed to the dietary intake of the insects.

Low amounts of pyridoxine were observed (<1.0 mg/100 g) for both grasshoppers (Table 3). Assay for thiamine was also done, but no detectable amounts were observed. This was consistent with the results reported by Finke (2002) for most of the edible insects analysed.

Table 4 shows the fatty acid composition of the green and brown grasshoppers. Palmitic acid was the major fatty acid (31.52% and 32.12%) green and brown grasshopper respectively although linoleic acid was only slightly lower in content (31.21% and 29.54%) in green and brown grasshopper respectively.

Table 4: Fatty acid composition of the lipid fraction

Fatty acid (%)	*Ruspolia differens* (Green)	*Ruspolia differens* (Brown)
Capric acid (C10:0)	0.4 ± 0.1^{a}	0.2 ± 0.1^{a}
Lauric Acid (C12:0)	nd	nd
Myristic Acid (C14:0)	0.9 ± 0.6^{a}	0.7 ± 0.4^{a}
Palmitic Acid (C16:0)	31.5 ± 0.7^{a}	32.1 ± 0.2^{a}
Palmitoleic Acid (C16:1)	1.9 ± 1.1^{a}	1.4 ± 0.1^{a}
Stearic Acid (C18:0)	5.5 ± 0.2^{a}	5.9 ± 0.1^{a}
Oleic Acid (C18:1)	24.6 ± 1.5^{a}	24.9 ± 1.2^{a}
Linoleic Acid (C18:2)	31.2 ± 0.3^{a}	29.5 ± 0.2^{b}
Linolenic Acid (C18:3)	3.2 ± 0.2^{a}	4.2 ± 0.5^{a}
Total saturated [1]	38.3 ± 0.4^{a}	39.1 ± 0.2^{a}
Total Unsaturated [2]	60.9 ± 0.8^{a}	60.1 ± 0.5^{a}
Monounsaturated [3]	26.6 ± 1.3^{a}	26.3 ± 0.6^{a}
Polyunsaturated [4]	34.4 ± 0.2^{a}	33.8 ± 0.4^{a}

Values on the same row followed by the same letter are not significantly different ($p > 0.05$)

[a] Fatty acid content expressed as percentages of total methyl esters. Fatty acids are denoted by their common name, number of carbons and number of double bonds.

[1] Sum total percentage of 10:0, 12:0, 14:0, 16:0, 18:0

[2] Sum total percentage of 16:1, 18:1, 18:2, 18:3;

[3] Sum total percentage of 16:1, 18:1

[4] Sum total percentage of 18:2, 18:3

nd - Not Detected

n=6

Other researchers have reported small amounts of arachidonic acid in insects (Oyarzun *et al.*, 1996; Ekpo and Onigbinde, 2005; Ekpo and Onigbinde, 2007). However, this fatty acid was not detected in the samples analysed. Bozkus (2002) reported that arachidonic acid, among other polyunsaturated fatty acids occur in low proportions, and are reported in only a few instances. They are probably routinely present in the lipids of most insects, but are often overlooked because they are not present in easily detectable quantities.

The grasshoppers had polyunsaturated fatty acids (PUFA) concentration of 34.4% and 33.8% for the green and brown grasshopper respectively (Table 4). Ekpo and Onigbinde (2005) reported 17.7% PUFA content in edible larvae of *Rhynchophorus phoenicis* (F) and a 61.1% degree of unsaturation of the fatty acids. The PUFA in grasshoppers was dominated by linoleic acid (C18:2) at 31.2% and 29.5% while linolenic acid was 3.2% and 4.2% for green and brown grasshoppers, respectively. These are the essential fatty acids required in the human body.

The presence of these essential fatty acids such as linoleic and linolenic acid points to the nutritional value of the grasshoppers' oil. Nutritionally, a high level of saturated fatty acids in foods might be undesirable because of the linkage between saturated fatty acids and atherosclerotic disorders (Reiser, 1973).

The ratio of polyunsaturated to saturated fatty acids (P/S) has been used widely to indicate the cholesterol lowering potential of a food. A P/S ratio of below 0.2 has been associated with high cholesterol level with high risk of coronary heart disorders (Mann, 1993). The P/S ratio of 0.89 and 0.86 for green and brown grasshoppers suggest that the insects can be associated with a lower risk for coronary heart diseases.

Table 5 shows the lipid fractions obtained from the grasshoppers' oils. The neutral lipid fraction was the major fraction, followed by the phospholipid fraction. The neutral lipid fraction comprises mainly of triacylglycerols, and this is an indicator of the high caloric value of the insect oil (Ekpo and Onigbinde, 2007).

Phospholipid functions as the principle components of cell membranes and this therefore makes phospholipids essential for all vital cell processes. Phospholipids are the most important membrane building compounds that occur in human, animal and plant cells (Gary, 1995).

Table 5: Lipid classes in grasshoppers' oil

Lipid Fraction (%)	*Ruspolia differens* (Green)	*Ruspolia differens* (Brown)
Neutral lipids	89.4 ± 1.8^{a}	84.3 ± 0.2^{b}
Phospholipids	7.4 ± 0.7^{b}	9.3 ± 0.9^{a}
Glycolipids	3.2 ± 0.3^{b}	6.4 ± 0.4^{a}

Values on the same row followed by the same letter are not significantly different ($p>0.05$)
n = 6

4.0 CONCLUSIONS

This research provides an overview of the nutrient composition of longhorn grasshoppers (*Ruspolia differens*). It confirmed the empirical knowledge of local people in a scientific way. The insects were found to contain significant proportion of proteins, fats and other nutrients. Consumption of 100 grams of the insects contributes significantly to the recommended daily requirements of retinol, á-tocopherol, niacin, riboflavin and folic acid as well as iron, zinc, calcium and potassium. In addition, the insects were found to contain essential fatty acids important for human growth. This knowledge therefore creates a justification that the grasshopper is an important food item that needs industrial application and commercialisation.

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