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Original Research Article

Nutrient composition of four species of winged termites consumed in western Kenya

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ABSTRACT

The objective of this study was to gain knowledge on the nutrient composition of *Macrotermes subhylanus*, *Pseudacanthotermes militaris*, *Macrotermes bellicosus* and *Pseudacanthotermes spiniger* termite species consumed in western Kenya. Proximate, iron, zinc, calcium and fatty acid composition were analysed in order to ascertain their potential in food-based strategies to improve nutritional health. The fat content was 44.82–47.31 g/100 g, protein 33.51–39.74 g/100 g, available carbohydrate 0.72–8.73 g/100 g, iron 53.33–115.97 mg/100 g and zinc 7.10–12.86 mg/100 g. The level of unsaturated fatty acids was 50.54–67.83%, while n-6:n-3 ratio ranged between 5.80:1.00 and 57.70:1.00, signifying potential nutritional and public health significance. The termites may be exploited to provide high-quality diets especially in the developing countries, which have been plagued by iron and zinc deficiencies as well as poor supply of dietary polyunsaturated fatty acid sources.

1. Introduction

According to FAO (2010), more than 2.5 billion people, mainly in Africa and Asia, commonly eat insects. Currently attention is being drawn to this valuable traditional food resource, which if tapped or exploited is likely to be a more sustainable solution for nutrient deficiency. Edible winged termites form an important part of the food culture in the Lake Victoria region of East Africa (DeFoliart, 1999; Ayieko, 2007). In many households termites are a delicacy enjoyed by almost all ethnic communities in western Kenya.

There are different species of edible winged termites collected for human consumption in western Kenya. Depending on the termite species and season, methods of harvesting vary (Ayieko et al., 2010). In the western Kenya region, termites are collected during the April and October rainy seasons. They are prepared by blanching in boiling water then drying in the sun, and then frying in their own fat. They are consumed as part of a meal or as a complete meal with tapioca, bread, roast corn, or simply eaten as snack food. Some mothers even grind the dried termites into flour and use it as a sprinkle in baby porridge (Bergeron et al., 1988). Termites are also eaten raw directly from the emergence hole (Christensen et al., 2006; Ayieko et al., 2010).

Although termite harvest begins with the onset of the rains and the swarming of the winged termites, villagers have shown that some termites could be induced to emerge even during the dry seasons, making them available throughout the year. This has created attachment to the termite enterprise by locals to the extent that in some parts of the region, termite mounds are owned by individuals and sometimes form part of inheritance when one dies (Banjo et al., 2006).

It is postulated that termites contain high-quality nutrients including highly digestible proteins (Kinyuru et al., 2010a), as well as minerals, which are more bioavailable than minerals from plant foods (Omotoso, 2006). They may therefore be utilised to manage the widespread nutrient deficiency in developing countries

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(FAO/WHO, 2001) practising entomophagy. Most of the literature concerning the comprehensive nutrient composition of insects in western Kenya has focused on other insects such as grasshoppers (*Ruspolia differens*) [Kinyuru et al., 2010b] and black ants (*Calebara vidua*) (Ayieko et al., 2012). Christensen et al. (2006) summarised the mineral content of 'oyala' 'ogawo' and 'agoro' termites from Lake Victoria region of Kenya. Another study focused on the culture of harvesting and consuming *Macrotermes subhylanus* termite in western Kenya (Ayieko et al., 2010). Therefore, this report provides a more comprehensive summary of the proximates, mineral and fatty acid composition of four termite species commonly consumed in western Kenya.

2. Materials and methods

2.1. Sampling design

Representative samples of sun-dried *M. subhylanus*, *P. militaris*, *M. bellicosus* and *P. spiniger* termite species were collected from markets in six major towns namely Maseno, Luanda, Mumias, Bungoma, Webuye and Kakamega. Samples were collected from six vendors in each town during the wet season between April and October in 2010. From each vendor, samples weighing 0.25 to 2 kg of each termite species were obtained. A single sample per town for each species was obtained by pooling 100 g from each vendor. This formed six composite samples for analysis for each termite species representing western Kenya. The samples were packaged in standard gauge polythene bags and stored in cool boxes lined with ice packs. They were transported to the Food Biochemistry laboratory at Jomo Kenyatta University of Agriculture and Technology within 12 h after collection.

2.2. Sample preparation and analysis

Once in the laboratory, the composite samples were dewinged and moisture content determined. The rest of the samples were freeze-dried, homogenized and stored at −20 °C for further analysis. All the reagents for analysis were of analytical grade.

2.3. Proximate composition

Moisture content was analysed by the drying method, crude fat by Soxhlet extraction method and crude protein by semi-micro-Kjeldhal method (AOAC, 1996). Protein content was calculated by utilising 6.25 as the protein: nitrogen ratio. Crude ash was determined by incinerating in a muffle furnace at 550 °C (AOAC, 1996). Dietary fibre was determined by enzymatic gravimetric method – Prosky (AOAC, 1995). Available carbohydrate value was calculated as the difference between 100 and the sum of the percentages of water, protein, lipids, ash and dietary fibre.

2.4. Iron, zinc and calcium content

Quantification of iron, zinc and calcium was performed by atomic absorption spectrometry (AAS) (Shimadzu AA-6200, Tokyo, Japan) according to AOAC (1996) using external standards (Sigma–Aldrich Chemie, Steinheim, Germany). In-house control material was used to determine the precision and accuracy of the results. The in-house control sample was vacuum-packed in polythene bags and stored at −20 °C. The stability of this material was tested regularly.

2.5. Fatty acid composition

Fatty acid composition was determined by gas chromatography. The extraction of the lipids was performed by Folch extraction method (Folch et al., 1957). Prior to methylation, the extracted lipid was redissolved to a concentration of 10 mg/mL in chloroform:methanol (2:1, v/v). The samples were methylated according to Bligh and Dyer (1959) and 0.2 μL were injected into the Gas Chromatograph (GC) capillary column (Supelcowax, internal diameter 30 m × 0.53 mm) maintained at an injection/detection temperature of 220 °C under a flame ionisation detector. Identification of the fatty acid methyl esters was by comparison of retention times with standards (Sigma Chemical Co) and was expressed as percentages of total methyl esters The polyunsaturated fatty acids/saturated fatty acids ratio (PU/SA) and n-6:n-3 fatty acids ratios were calculated (Mann, 1993; Nurhasan et al., 2010).

2.6. Data analysis

Data were reported as mean ± standard deviation for each termite species.

3. Results and discussion

3.1. Proximate composition

Table 1 shows the proximate composition of the edible termites. Moisture content for termites was found to be 6.50–8.76 g/100 g, values which were higher than those reported in National Food Composition Tables for Kenya (NFCT) [Sehmi, 1993] for sun-dried termite consumed in western Kenya (1.70 g/100 g). The level of moisture content in any dried food is highly dependent on the drying environment among other factors. Some of the foods are dried on bare ground; water may therefore accumulate around it instead of draining away during the drying process making the drying process cumbersome (Owaga et al., 2010). These are some of the reasons why there may have been a difference in the moisture content observed between the species.

The fat content of the termites (44.82–47.31 g/100 g) was lower than the values reported in NFCT (Sehmi, 1993) for sun-dried termite (53.40 g/100 g) but higher than the values reported for other termite species studied by Banjo et al. (2006) (19.70–24.10 g/100 g) in Nigeria. The values of the studied termites were also higher than that of *Nausitermes* spp. termite (40.23 g/100 g) reported by Oyarzun et al. (1996).

The protein content of the four termite species (33.51–39.74 g/100 g) was within the range reported for dried termite (35.70 g/100 g) reported in the NFCT (Sehmi, 1993). The protein content

Table 1
Proximate composition of the edible winged termites (g/100 g).

Termite	Moisture	Protein[a]	Fat[a]	Total ash[a]	Dietary fibre[a]	Available carbohydrate[a]
Macrotermes subylanus; dewinged	6.50 ± 0.02	39.34 ± 0.12	44.82 ± 2.89	7.58 ± 0.05	6.37 ± 1.18	1.89 ± 0.76
Pseudacanthotermes militaris; dewinged	5.04 ± 0.15	33.51 ± 0.85	46.59 ± 2.13	4.58 ± 0.06	6.59 ± 0.07	8.73 ± 1.87
Macrotermes bellicosus; dewinged	5.13 ± 0.18	39.74 ± 0.61	47.03 ± 1.04	4.65 ± 0.09	6.21 ± 2.04	2.37 ± 0.98
Pseudacanthotermes spiniger; dewinged	8.76 ± 1.61	37.54 ± 0.12	47.31 ± 0.13	7.22 ± 0.38	7.21 ± 0.44	0.72 ± 0.01

Values are mean ± SD; $n = 6$.
[a] Values are on dry weight basis.