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PROXIMATE COMPOSITION OF *Pseudocanthotermes grandiceps* (Isoptera: Termitidea) IN WESTERN KENYA: COMPARISON WITH NILE PERCH FISH AND RED MEAT

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Abstract: **Food insecurity is a major problem facing the Kenyan populace. There are acute food shortages that do not satisfy the increasing population as traditional food stocks continue to be depleted as a result of environmental changes and increasing population. Faced with problems of food insecurity, increasing food prices and over-reliance on the traditional food items, there is an urgent need for Kenyans to diversify their food sources. In western Kenya, the termites have a long history of consumption as a delicacy during the rainy seasons. A major problem is that they are varied in species and may not all contain the ingredients required by humans for nutrition. There are also very few studies that have attempted to evaluate the totality of white ants in Kenya. The aim of this study was to determine the proximate composition of the termites in Western Kenya. This was done with an overall aim of determining whether termites can be declared as an alternative food source in Kenya. Data were collected and analyzed for proximate composition of moisture, protein, lipids, crude fiber. Essential Amino Acid (EAA) profiles were evaluated to determine protein composition. Food value of the different species was analyzed by Analysis of Variance (ANOVA). Results indicated that termites have high levels of moisture content of 90.2% crude protein (64%), crude lipids (9.35%), crude fibre (9.53), gross energy of 4.99 kcal and the essential amino acids at 31.5g/100g. Due to the conditions of families in Kenya this can be a substitute for the sources of protein substitute for red meat and Tilapia fish meals preferred by many households. The profile of Essential Amino Acid in the current study was found to be high and therefore white ants formed a very good source of essential amino acid to the local people. This study therefore concludes that white ants are suitable alternative food source to replace major rotein food and nutritionists should start a campaign of making the white ants a delicacy. Given that white ants are neglected food in Kenya, it is recommended that the food items should be consumed as one of the food in the traditional diets in areas where the species occur.**

Keywords: **proximate, composition, termites, *Pseudocanthotermes grandiceps*, Isoptera, comparison.**

1. INTRODUCTION

Termites live in colonies consisting of a few thousands to several million individuals. Termites are a moderate sized insect order (2600 described species) accepted to be an extremely important part of tropical and sub-tropical ecosystems (Eggleton, 2001). The tropical environment is known for its rich fauna and enormous population of termites, which are

supposed to play an important role in the rapid turnover of organic matter in the ecosystem (Onyonka, 2001). The seventh family, Termitidea, represents over 80% of all termite genera and 74% of all termite species. Due to location in the tropics and climate, Kenya, like most of the tropical environment possesses one of the most diverse biota in the world. The genus *Nasutitermes* is taxonomically diverse with over 180 species (Krishna, 2010) and broadly distributed, being found in six of the eight major biogeographical regions (Pearce and Waite, 1994).

termites have been historically consumed in many parts of the world for time immemorial. Its delicacy is well known to be safe for consumption many people in Kenya (Onyonka, 2001) and its abundance is unquestionable. It is apparent in Kenya that there is problem of food insecurity, which has been a major issue that the Government has been addressing. The population growth rate in Kenya is increasing at a rate of 6%.

Historically, Kenya has relied intensely on agriculture to support more than 70% of her population. In the 1970s, sustained growth of agriculture above 10% per annum coupled with favorable weather patterns, witnessed unrivalled increase in Kenya's gross domestic product (GDP) by over 7% annually and therefore, the momentous economic growth was sustained, reducing food insecurity problems. Currently, the country continues to rely heavily on agriculture as an engine to drive most of its economic growth, provide food, employment and most of the basic needs required by the populace despite the myriads of problems that has continued to duck the sector (Odeny, 2006). However, in Kenya for quite some time now, food insecurity situation has been appalling because of frequent problems of unpredictable weather conditions as well as erratic and intermittent rainfall partly attributed to wanton dynamism in environmental conditions and poor agricultural policies put in place (Waiganjo et al., 2006; Were et al., 2008). With the liberalization of trade and introduction of structural adjustment programmes (SAPS), fertilizer costs have increased to a level unaffordable to small-scale farmers. Rather than rely on agriculture to wholly engineer the economic growth other sources of foods need to be considered. In an effort to bridge the food gap that ails the country, several food sources have been evaluated. Many of these protein food sources have been based on meat and beef products and byproducts. They include animal protein sources such as chicken, beef, burgers, duck, turkey, pig meals among others as well as plant protein sources such as peas, beans, French beans, soybean etc. Whereas they have been providing protein sources for a long time now, they are increasingly becoming expensive and out of reach for many people. Furthermore, livestock are prone to diseases and drought as well as lack of pasture not to mention the constant conflicts that are associated with rearing large heard of cattle. Kenya depends on agriculture to satisfy its food demands. In recent years there have been foreseen and unpredictable weather changes that have exposed the people to poor harvest and declining yields from agriculture. There is therefore, the grave danger of chronic and sometimes acute food shortage that is likely to affect the nutritional and health status of the people. To reduce the chronic food shortages in Kenya, variety of food sources are required white ants being one of them. However, the nutritional composition of the white ants that would render it suitable as a food source is unknown, hindering the protocol of declaring it a national food item.

2. MATERIALS AND METHODOLOGY

This study was carried out in Western Kenya Covering Western Province, Nyanza Province and part of the North Rift (Figure 1). In presence of diverse livelihood mainly in the agricultural sector, close to 4 million people have settled in the region, attributable to employment prospects while others are in the District due to immigration. The study area is situated about 300-800 km North West of Kenyan Capital, Nairobi. It lies at an average altitude that ranges between 1800-2600 meters above sea level. The area covers an approximate area of 19200 km2. Climate within the study area is strongly influenced by altitude and physical features such as escarpments and volcanic peaks mainly from the Cherangani Hills, to Kakamega forest and hills of Mount Elgon. The area has a high variation in temperature ranging from 10.5 –25.5ºC within the year thus favoring growth of agricultural crops within the area. There is a bimodal rainfall; the mean being just over 1000 mm annually.

Populations and land tenure:

It is estimated that the area has slightly over 4 million persons with a density of about 320 persons per square kilometer (KNBS, 2010). The number of households within the study area according to 2010 census is approximately 822,850. Land is under individual ownership and partly through cooperates such as the several forest farms spread along the breath of the area.

Experimental Design:

Proximate composition of termites, fish and meat was done by proximate analysis of moisture content, nitrogen free extracts, crude protein, crude lipid, and ash and crude fibers. Amino acid profiles were also evaluated to determine the protein components.

Collection of white ant samples:

White ants were collected from various parts of Bungoma County and West Pokot county of Western Kenya during long rain periods when they are expected to be available. Colonies were marked and mapped, and 50% of the colonies were re-sampled during any time there was termites. The selection of the sampling sites was randomized. Collection of the white ants was done using traps which were mounted on the termite mound to trap the alates. Collections were also made by breaking open the termite mound. Some of the alates and a number of small or large soldiers and workers were preserved (in 70-80% ethanol) for identification at the National Museums of Kenya. Approximately 100 live individuals from each colony were Sun-dried after suffocating them in polythene bags. They were also stored in containers with tight lids. Collections did not discriminate between small or large workers, or soldiers.

Proximate analysis:

The collected white ants were analyzed for proximate composition of crude protein (N2×6.25), crude lipid content, moisture, and ash content using standard methods detailed in AOAC (1995). Dry matter (DM) was determined by oven drying them at 110°c until a constant weight was obtained. Crude protein (N ×6.25) was determined by Kjehdal method after acid digestion. Crude lipid was determined by the Soxhlet apparatus. Ash content was determined by incineration in a furnace at 550°C for 24 hrs. Crude fibre was determined by digestion with 1.25% H2SO4 and 1.25% NaOH solutions. Nitrogen free extracts (NFE) was calculated from the differences. Gross energy was calculated using conversion factors for protein, lipids and carbohydrates provided in Tacon (1998) and confirmed by adiabatic bomb calorimeter. Amino acid compositions of the white ants were determined by automated amino acid analyzer after hydrolyzing the sample for 24 h with 6 M HCl at 110°c. Sulphur-containing amino acid was oxidized using performic acid before acid hydrolysis. All Analyses were performed, in duplicate, on the sub samples of white ants.

3. RESULTS

The ingredient compositions and the profile of the essential amino acids (EAA in g/100 g feed) of the white ants when compared with red meat and Tilapia are provided in Table 1. Moisture content was highest in white ants forming 70% of the body weight of the white ants. Protein content of the white ants was found to be 64% which was significantly the highest among the food items analyzed ($p < 0.05$). Crude lipid content of the white ants was about 9%, which was significantly ($p < 0.05$) the highest when compared to the red beef and Tilapia fish. White termites had crude fibre content of 10% significantly highest ($p < 0.05$) in comparison to the red meat and Tilapia fish. Gross energy derived from consumption of 100 g of ants was 4.99 kcal, which was significantly ($p < 0.05$) the highest than the gross energy derived from fish and beef. The profile of the amino acid of the white ants were also analyzed and based on the essential amino acid scores, EAA of the white ant was the highest (31.5 g/100g) while that of fish was the lower. However, the profile of the EAA score as a percentage of the crude proteins in the white ants was at 46.8% higher than in both red meat and Tilapia which was at 46.0% and 46.2% respectively.

4. DISCUSSION

Analyzing the proximate content of the termites relative to red meat and Tilapia fish which are the traditional protein contents for the local community members. Moisture content, Proteins, lipids, and crude fibre as well as the caloric values were the major constituents, which had been considered in evaluating the nutritional value of the food items studied. Analysis of the ingredient compositions and the profile of the essential amino acids (EAA in g/100 g feed) of the white ants when compared with two other protein diets: red meat and Tilapia fish, commonly consumed by the local community members indicated that protein content was highest in the white ants at 63.9% compared to 56.9% and 52.2% respectively in Tilapia fish and red meat. The protein content in the white ants is also higher in comparison to the poultry products (Cherop et al., 2009). This is in-line with the report of Stephen (2005), that moisture content forms the largest quantity in many insects, Tilapia fish and red meat. The variations recorded in the concentration of the different proteins in the white ants, Tilapia fish and red meat examined could have been as a result of the ability of these organisms to absorb and convert the essential nutrients from their diet or the environment where they live. This is supported by the findings of Stephen et al., (2005). This makes the white ants important living resource of dietary protein better than other food like

Tilapia fish and red meat. White ants were richest in lipids with 9.35% making it the most preferred source of fats and oils. Fats and oils (hereby referred to as lipids), and thus triglycerides, are present in both animals and plants. Some fat is required within the diet to supply important fatty acids, which are essential regulatory elements. Body fat is needed within our diet as indicators of delivering two essential fatty acids, linoleic acid, an _-6 PUFA, and _-linolenic acid, an _-3 PUFA (GoK,2006).

The dietary requirements of other food items such as fibres are important in digestion of the food items. Therefore the value presented in this study of the crude fibre is very useful as fibres enhance digestion of the food in the body

Table 1: Proximate composition (g100 g-1) of the termite meal, red meat and Tilapia

	Food items			ANOVA	
Ingredients (% as fed basis)	White ant	Fish	Beef	F-value	p-value
Dry matter	90.2 ± 1.32	89.6 ± 1.21	90.21 ± 1.02	0.432	0.532
Crude protein	53.9 ±	66.9 ± 1.76^{c}	62.22 ± 1.32^{b}	5.42	0.004
Crude lipid	9.35 ±	5.54 ± 1.04^{a}	6.23 ± 1.07^{a}	9.785	0.000
Ash	10.81±	3.31 ± 0.08^{a}	3.30 ± 0.09 ^{a}	10.225	0.000
Crude fiber	9.53 ± 2.32	8.27 ± 2.22	10.24 ± 2.94	1.954	0.094
NFE	6.61 ±	5.58 ± 1.21^{a}	8.03 ± 1.25^{b}	3.963	0.013
Gross energy (kcal 100 g^{-1})	4.19 ±	4.53 ± 0.23	4.43 ± 0.24	1.562	0.234
Essential Amino acids (g 100g^{-1})					
Histidine	3.02	3.95	2.25		
Isoleucine	2.56	2.98	3.31		
Leucine	2.36	2.64	2.41		
Lysine	5.79	5.21	5.04		
Methionine	2.78	3.56	3.51		
Phenylalanine	4.01	5.39	4.92		
Threonine	2.64	4.01	4.22		
Valine	1.32	3.87	2.99		
Total EAA	24.5	30.6	28.6		
Ratio:EAA:CP	45.4	46.2	46.0		

Means in each column followed by the same letter (a&b) are not significantly different ($p < 0.05$).

Termites were the major source energy supply with 4.99 kcal energy per 100 g, than the Tilapia fish and red meat which had 4.53 and 4.43kcal/100g feeds energy after consumption. The profile of the amino acid of the feeds were also analyzed and based on the essential amino acid scores, EAA of the white ant was the highest (31.5 g/100g) while that of red meat was the lowest (30.1).The essential amino acid are critical in brain growth and development especially in children. The

present work reveals the importance of white ants as good sources of protein and lipids due to the high contents of the substrates which are of paramount on the nutritional value

5. CONCLUSION

White ants are a valuable source of nutrition in rural areas and contribute substantially to protein and lipids intake. This was evident from the availability of high quality protein content and other ingredients that would render it suitable food to be used overally utilized by the communities.

6. RECOMMENDATIONS

It is recommended that white ants should be considered a delicacy and be advocated for all the Kenyans to consume reduce over-reliance on the Tilapia fish and red meat. Ways of enhancing commercial production of the white ants should be improved to ensure that termites are available as a major food source, campaign of making the white ants a delicacy should be started by all the relevant stakeholders and further determination of quantity of nutrients should be undertaken in the various species of white ants at an advanced stage to enhance its wide acceptability using nutritional information.

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