Available online at www.elixirpublishers.com (Elixir International Journal)

Applied Chemistry

Elixir Appl. Chem. 75 (2014) 28020-28023

ISSN: 2229-712X

Evaluation of the nutritional value of reproductive and non reproductive termites (*MacrotermesBellicosus*)

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ARTICLE INFO

Article history:
Received: 17 July 2014;
Received in revised form:
25 October 2014;
Accepted: 30 October 2014;

Keywords
Termite, Vitamins,
Antinutrient, Mineral,
Macrotermesbellicosus.

ABSTRACT

The nutritional value of the reproductive (alates) and non reproductive (workers/soldiers) termites *(Macrotermesbellicosus*) were evaluated. The result showed that the non-reproductive termites contain moisture (6.62±0.12mg), crude ash (11.35± 0.01mg), crude fat (13.00± 0.14mg), crude protein (14.58±0.15mg), carbohydrate (462.9 ± 0.01cal)and caloric value (362.48±0,01Kcal), vitamin A (16.30±0.11mg), vitamin C(26.00± 0.13). The mineral element concentration in mg/100g in the non reproductive termites were 22.02±0.01, 14.32±0.03, 6.55±0.03, 13.64±0.02, 4.2± 0.02, 2.08 ± 0.03, 7.16±0.01, 5.35±0.02, 21.40±0.01 and 9.12 ±0.11 for Ca, Mg, Na, K, P,Zn, Mn, Cu, Fe and I_2 respectively. The antinutrients content in the non- reproductive termite were HCN; 1.93±0.01mg, phytate; 2.80±0.02mg, Tannins; 2.50±0.03mg, Alkaloids; 1.58±0.02mg and; Saponins; 0.20±0.02mg. Comparatively, the results of this study, show that the reproductive termites contain lesser concentration of toxicants but higher proximate, vitamins and mineral compositions than the non reproductive termites. Hence the reproductive termite (alates) has a higher nutritional value than the non reproductive (soldiers/workers) termites.

Introduction

Insects and other related invertebrates including arachnids have served as a food source of people for tens of thousands years the world over so much that most people consume insects for their nutritional value as well as for taste (Ashitu, 1988).

Common and popular insects and arachnids that are eaten around the world include crickets, cicadas, grasshoppers, ants, a variety of beetle grubs such as meal worms and larva of the darkling beetle. Also eaten are species of caterpillar commonly referred to as worms. They include bamboo worm, silkworm, wax worms as well as scorpions and tarantulas (FAO, 1992).

Today insects eating is rare in the developed world but insectivory remain popular in many developing regions like- Thailand, Vietnam, China, Cambodia, Africa, Mexico, Columbia, New Guinea to mention but a few (Tutin, 1992; Goodal, 1986). Dufeur (1987) opined that insects preference to vertebrates might not be unconnected with their higher food conversion efficiency. A measure of efficiency of conversion of ingested food, which is almost 20 times higher than most meat. Another reason for their high preference is that insects have high reproductive rate. For instance a female cricket can lay from 1,200 - 1500 eggs in 3-4 weeks. In view of this advantage over higher animals some people have proposed the development of entomophagy to provide a major source of essential amino acids in human nutrition. Thus while many insects can have energy input to protein output ratio around 4:1, raised livestock has a ratio close to 54:1 (Fasoranti&Adjiboye, 1993).

Research on entomophagy has shown that the use of insects as sources of nutrient and as condiment has resulted intheir exploitation and consequent decline in some places (Julieta, 2006). This practice may be difficult to control because researches have also show that insect are not only a good source of protein and fats but also of vitamins and minerals (Warner 1991; Julieta, 2006).

Gordon, (1998) also reported that most insects contain abundant stores of essential amino acids including lysine; an amino acid that is deficient in the diet of people who depend heavily on grains.

Apart from serving as food, insects are also reported to be a source of infectants, ingestants, contactants and inhalant allergens (Gorham, 1991). Some serve as vectors or passive intermediate hosts of vertebrate pathogens such as bacteria, protozoa, viruses or helminthes (Joel, 1995). In addition to the toxins they harbour, insects have higher tendency of retaining pesticides through bioaccumulation and this can make them unsuitable for human consumption (Capinera, 2004).

One edible insect widely consumed in rural communities of Nigeria especially AkwaIbom State is the termite. Termites *(Macrotermesbellicosus)* are social insects that build large nests in soil or wood and can occasionally cause damage to wooden structures. They are sometimes called white ants. However, they belong to a complete different insect group (order:*isoptera)* or true ants (order:*hymenoptera)* (Phelps *et al;* 1975).

The features, habitat and life cycle of *Macrotermesbellicosus* show that they have pale-brown to white bodies with darker head and no waist between the thorax and the abdomen, Termites appear in two forms, the reproductive and non reproductive forms. The reproductive forms never develop wings. They are blind and have abdomen that make them vulnerable to drying out. The reproductive forms have two pairs of equal sized wings, a pair of compound eyes and a thicker abdomen that protects them better from drying out when exposed to harsh weather (Fink *et al*, 1989).

Termites live in nests formed either in trees, soil mounds or underground. Fasoranti and Adjiboye (1993) identified the main

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types of nests to include ground mounds, tree nests formed outside the trees but connected to internal cavity, pole nests formed on human structure such as fence, post and poles, subterranean nest formed underground in soil, stumps and tree bases and tree or wooden nest formed inside the trees.

The life cycle of the termite begins with a mating flight where experienced winged reproductive males and females leave the colony and swarm and then go on to procreate. After fertilization, winged termites settle on land, shed their wings and go on to form new colonies where a male and female reproductive termite respectively become the king and queen of their newly established respective colonies.

Ene (1963) reported that the king and queen termite are the centre of the termite life cycle and are solely responsible for reproduction. Over the course of several molts, the eggs laid by the fertilized queen which had hatched into pale white larvae grow to assume the role of the three termite colony castes (Workers, Soldiers and the reproductive termites also called alates) with each caste having a distinctly different physical appearance. The workers are sexually and developmentally immature insects that are responsible for constructing tunnels chambers as well as feeding other termites castes. Soldiers are yellow brown in colour with dramatically enlarged heads and mandibles useful during combat (Crenelik, 1969).

The alates are black in colour and are born with two pairs of wings Although it is not clear how larvae are relegated to a certain caste, research has indicated that maturity and the overall need of the colony may dictate caste assignment (Kok*et al*, 1991). Thus caste in the termite life cycle is not rigidly set as termites belonging to one caste may develop into another if the colony requires it. For instance, the soldier termite may become a worker or a reproductive termite if the colony experience shortage of one or the other. This life span of termite caste varies; workers and soldiers live appropriately 1- 3 years while the queen and king may survive up to 5 years under optimal climate conditions (Phelps *et al*, 1975). Studies on the chemical composition of termitarium soils and fungal combs of *Macrotermesbellicosus*was reported by Ntukuyoh*et al*, (2012).

Rural dwellers in the eastern part of Nigeria especially AkwaIbom State eat termites raw. Others prefer the processed form which can be by drying the insects in the sun, frying in hot oil or grinding to powder and using it as soup ingredient.

The frequency and high consumption rate of this Social insect have necessitated the assessment of its nutritional value with the hope of adding to the available literature on food value of insects.

Materials And Methods

An entomological net was used to collect the reproductive male and female termites which swarm from established colonies during their mating flight. They were left overnight to shed their wings. The non reproductive termites were collected from an identified nest by pulverizing the soilmound and collecting them with an insect trapping net.

The reproductive and non reproductive termites were washed differently in clean water to remove any dirt. Each termite caste was spread out as a mono-layer of termites on non-perforated trays and allowed to dry in air but without exposing them to sunlight. When they were properly dried, the" termites were ground to powdered form in an electric blender (Binatone, BLG 802 Model) and stored in labeled airtight containers from which required quantities were scooped out for chemical determination. All the chemical analyses were conducted in Biochemistry Lab, University of Uyo in AkwaIbom State.

The various proximate constituents in the samples were determined by method of the Association of Official Analytical Chemist (AOAC, 2006). Sodium and potassium were determined by flame photometric method described by AOAC, (1990) procedure, Phosphorus by calorimetric procedure (AOAC,1990) while other minerals were determined using an absorption spectrophotometric (AOAC, 1993).

Tannin and Hydrocyanic acid contents were determined by the Vanillin - Hydrochlorine reagent method (Burns, 1981) Phytate by Molybdate - Hydroquinone reagent method (AOAC, 2006), Alkaloids by method of Harboune (1978), while saponins was determined by the method described by Trease and Evans (2008). Vitamins A and C in the samples were determined by method of (AOAC, 2003).

Results

The results of the nutritional value of termite are presented in tables 1, 2, 3 and 4.

Table 1: Results of proximate composition of termite in mg/l00g

Parameter	Non reproductive	Reproductive Termite
Moisture	6.62±0.12	8.14±0.11
Crude Ash	11.35±0.01	12.60±0.02
Crude Fibre	14.28±0.02	10.30±0.02
Crude Fat	13.00±0.14	30.90±0.13
Crude Protein	14.58±0.15	28.94±0.10
Carbohydrate (Cal)	462.9±0.01	17.26±0.01
Caloric Value (K Cal)	362.48±0.01	462.90±0.01

Values are mean of duplicate determinations ±S.D

Table 2: Results of Vitamins A and C contents of termite (mg/100g)

Vitamin	Non Reproductive	Reproductive Termite
Vitamin A	16.30±0.11	20.38±0.10
Vitamin C	26.00±0.13	36.80±0.12

Values are mean of duplicate determinations ±S.D

Table 3: Results of Minerals in termite (mg/100g)

Mineral	Non Reproductive	Reproductive Termite
Ca	22.02±0.01	12.31±0.01
Mg	14.32±0.03	17.00±0.04
Na	6.55±0.03	10.82±0.05
K	13.64±0.02	10.976±0.02
P	4.20±0.02	10.96±0.03
Zn	2.08±0.03	12.04±0.03
Mn	7.16±0.01	11.60±0.02
Cu	5.35±0.02	11.15±0.01
Fe	21.40±0.01	27.92±0.01
I_2	9.12±0.11	11.21 ±0.11

Values are mean of duplicate determination ±S.D

Table 4: Results of anti-nutrients in termite (mg/100g)

Toxicant	Non Reproductive	Reproductive Termite
HCN	1.93±0.01	1.60±0.02
Phvtic Acid	2.80±0.02	2.45±0.03
Tannins	2.50±0.03	1.72±0.02
Alkaloids	1.58±0.02	1.48±0.01
Saponins	. 0. 0±0.02	0.44±0.01

Values are means of duplicate determination ± S.D

As shown in Table 1, 100g of the non reproductive form of the termite contains moisture (6.62±0.12mg), crude ash (4.35±0.01mg), crude fibre (14.28±0.02mg), crude fat (13.00±0.14mg), and crude protein (14.58±0.15mg).

Comparatively, the same quantity of the reproductive termite contains 8.14±0.11mg moisture, 12.60±0.02mg crude ash, 10.30±0.02mg fibre, 30.90±0.13mg crude fat, 8.94±0.10mg crude protein. Table 1 also showed that the winged termites had a higher calorie value (462.90 Kcal) compared to the non reproductive (362.48 Kcal) termites.

Table 2 shows the vitamin A and C contents of the termite castes. From the results, the vitamin A content in mg/100g samples of the non reproductive termite and the reproductive termite was 16.30±0.11 and 20.38±0.10 respectively. Also, 100g winged termite sample contain 36.80±0.12mg vitamin C compared to 26.00±0.13mg of the vitamin in the non-reproductive termites.

The results of the mineral content in mg/100g as presented in table 3 shows that the reproduction termites contain Ca (12.31 ±0.01), Mg (17.00±0.04), Na (10.82±0.05), K (10.76±0.02), P (10.96±0.03), Zn (12.0±0.03),Mn (11.60±0.02), Cu (11.15±0.01), Fe (29.92±0.01) and 1_2(11.21 ±0.11). On the other hand, the non productive termite contain 14.32±0.03, 6.55±0.03, 13.64±0.02, 4.20±0.02, 2.08±0.03, 7.16±0.01, 5.35±0.02, 21.40±0.01 and 9.12±0.10 ca, Mg, Na, K, P, Zn, Mn, Cu, Fe and I_2 respectively.

Table 4 shows the results of toxicants in mg/100g of the termite samples. Whereas the reproductive termite contain HCN (1.60±0.02), Phytate (2.45±0.03), Tannins (1.72±0.02), Alkaloids (1.48±0.01) and Saponins (0.44±0.01), the non-reproductive termites contain 1.93±0.01, 2.80±0.03, 2.50±0.03), 1.58±0.02 and 0.20±0.02 HCN, Phytate, tannins, alkaloids and saponins respectively.

Discussion:

The results of the nutritional value of the termite samples are not quite different from the food value of most edible insects. Most researchers have shown that insects are not only a good source of protein but also of vitamins, minerals and fats (Julieta, 2006; Warner, 1991). For instance, Dunkel (1996) reported that giant grasshopper contain 20.9g protein, 6.1g fat and 3.9g carbohydrate. Cricket contains 12.9g protein, 5.5g fats, 75.8mg calcium and 9.5mg iron.

The presence of anti-nutritional factors in the termites is to be expected because of the sources of their food. These chemicals obtained from their foods accumulate in the insects and act as defensive secretions that may be reactive, irritating or toxic, Blium (1978) and Wiztl (1984) reported that these sequestered chemicals include phytochemicals like phenolics, tannins, terpenoids, alkaloids, cyenogenic glycosides, alcohols, hydrocarbons, ketones, lactones, aldehydes, carboxylic acids, glucosinulates and mimetics amino acids. However, the results of anti-nutrients in this insects are quite below the level where it can pose toxicity to the consumers.

Where these values are higher, adverse allergic reactions would have been the possible hazards (Joel and Wendell, 1995). This claim on insignificant anti-nutritional content may have been the reason. Dunkel (1996) emphasized that the long history of human use of insects suggest however with little evidence to the contrary, that the insects intentionally harvested for human consumption do not pose any significant health problem.

Conclusion:

In view of the fact that termites like most insect contain good proximate composition, essential minerals, vitamins A and C, as well as negligible amount of anti-nutrients; they can be substituted for food items and used as delicacies.

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