Haya: The Saudi Journal of Life Sciences (SJLS)
Scholars Middle East Publishers
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

ISSN 2415-623X (Print)
ISSN 2415-6221 (Online)

Evaluation of Nutritional Value of the Termite, *Macrotermes bellicosus* (Smeathman) and Beef

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Original Research Article

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Article History
Received: 04.10.2018
Accepted: 18.10.2018
Published: 30.10.2018

DOI:
10.21276/haya.2018.3.10.8

Abstract: The search for alternative protein food source coupled with the cost of affordability and the ever increasing human population has become a serious problem. This research was aimed at exploring other protein food sources than meat, using an arthropod of the class insecta, *Macrotermes bellicosus* (Smeathman), (termite). The nutrient content of the termite, an edible insect, and beef of the *Bos taurus* species was determined through various laboratory procedures including titration, digestion and distillation of the various samples. Termites used in the study triumphed over beef in terms of carbohydrate content (termites 22.4 ± 0.01, beef 1.34 ± 0.01) and there was only a slight difference in protein content of beef when compared to termites (beef 10.41 ± 0.01, termite 10.06 ± 0.01). The research revealed that beef contains more lipid (beef 25.0 ± 0.05, termite 20.0 ± 0.05), which can be detrimental to human health. Insects can be used as an alternative source of protein to effectively replace the expensive available source (meat) and solve malnutrition in the ever-growing population of mankind. There should be more enlightenment of the general public on the great benefits of insects consumption to avoid the under usage of this food resource.
Keywords: Proximate analysis, Nutrition, Beef, Termites, Protein.

INTRODUCTION

Today the search for alternative protein food source remains a problem as human growth is ever increasing under exploitation and underutilization of abundant alternative natural resources. The consumption of selected insects in diverse forms could be a positive response to this imperative.

Paoletti *et al.*, [1], has reported that insects are the most successful prolific species in animal kingdom, constituting about 76% of known species of surviving animals. Insects are regarded generally as man's enemy; they have medical, veterinary and agricultural importance as they serve as vectors of various tropical diseases such as Trypanosomiasis, Onchocerciasis, Malaria, Leishmaniasis, etc., and also cause severe economic losses to field, post harvest and stored products [2]. However, contrary to these detrimental attributes, insects are important in food security as they are pollinators of plants, agents of soil aeration and life support systems [3]. They are widely used for food and medicine and constitute a major source of protein. Besides this, various useful products are derived from them; these include honey, silk, shellac etc. Research shows that the use of insects as food (entomophagy) is fast gaining popularity in so many societies and are in most cases very abundant in their habitats, easily found and relatively cheaper compared to meat [4]. However, the general attitude towards insect eating is one of disgust, as we often tend to associate the practice with primitive behaviour and food meant only for the poor. Little wonder then that the consumption is generally low in some localities.

Insects are highly nutritious, containing other food nutrients aside protein, like minerals, vitamins and fats [5]. Insects are highly rich in minerals like calcium, iron, copper, manganese, magnesium and zinc [6]. Many insects contain abundant stores of lysine, an amino acid deficient in the diets of many people who depend heavily on grain [7]. Researchers have proved that crickets have more iron content than meat [8]. It has also been found that the copper, zinc manganese, magnesium and calcium in crickets, grasshoppers, and meal worms were more readily available for absorption than the same nutrients in beef [9, 10].

In Nigeria, a wide range of these insects are consumed at various developmental stages [11]. Termites of the genus *Macrotermes* is a major source of food to various human populations in the country and are usually gotten from ant hills or during their nuptial flights. They can be cooked, deep fried, fried with spices or roasted, and are very common during raining season. *M. natalensis* has been found to contain 74.35% of protein in terms of g/100 dry weight. Termites are also rich in vitamin B12 and C [12].

Beef is meat from cow; with the genus *Bos* being the commonest in Nigeria. Although beef consumption may have some negative impacts on human health, its consumption equally has some health benefits. A 3-ounce serving of beef is an excellent source of protein, zinc, vitamin B12, selenium and phosphorus, which means it provides at least 20 percent of the daily value for these nutrients per serving. However, apart from the relatively high cost of affording it among the local populace, research also shows that red meat consumption increases the risk of cancer, heart diseases, food borne illnesses and makes it harder to maintain a healthy body weight [13]. In the light of this, it stands to reason that, now is the time to consider commonly consumed insects species, as they could be excellent sources of bio- available iron and could provide the platform for an alternative strategy for increased mineral intake in the diets of humans and possibly address the health challenges associated with meat intake. In short, insects are capable of providing much of the nutritional needs of man at a lower financial and environmental cost. The greatest struggle however, will be changing our negative perceptions towards using it regularly as food.

MATERIALS AND METHODS

Study area, collection and treatment of sample

This work was carried out in Calabar South, Cross River State, Nigeria situated between (Latitude $4^0 58^1 32.578^1$ N and Longitude 8^0 20^1 30.124^1 E.). Termites, *Macrotermes bellicosus* [14] were collected from ant hills in staff quarters within Cross River University of Technology, Calabar Campus, while the beef meat, *Bos taurus* was bought from Watt market in Calabar. The termites collected were identified and authenticated by Entomologists in Biological Sciences Department of Cross River University of Technology, Calabar.

PROXIMATE ANALYSIS

The AOAC [15] official method of analysis was adopted for determining the moisture, lipid, protein, fibre and carbohydrate contents of both beef and insect samples.

Determination of moisture content

2g of each of the samples (beef and termite) was weighed into a washed and dried crucible. The sample was put in a moisture extraction oven at 105^0C and heated for 3hours. The dried sample was then put into a desiccator, allowed to cool and thereafter, reweighed. The difference in weight was calculated as a percentage of the original sample and the entire exercise was repeated for greater accuracy.

The percentage moisture was calculated from the formula:

$$percentage\ moisture = ws - w1/ws \times \frac{100}{1}$$

Where,

ws = weight of original sample
w1= weight of dry sample

Determination of Ash content

2g of each of the sample was weighed into a crucible and heated at 100 ^{0}C in a moisture extraction oven for 3 hours before transferred into a muffle furnace at 550^0C. Heating continued until sample turned white and free of carbon. Sample was then removed from the furnace, allowed to cool in the dessicators to room temperature and later reweighed. The weight of the residual ash was then calculated as ash content.

$$percentage\ ash\ content = \frac{w1}{w2} \times \frac{100}{1}$$

Where,

w1 = weight of ash
w2 = weight of original sample

Determination of fat

2g of each sample was wrapped with a filter paper and put into a thimble which was fitted to a clean round bottom flask washed, dried, weighed and having 120ml of petroleum ether. Each sample was heated with a heating mantle and allowed to reflux for 5hours. Heating was then stopped and the thimble with the spent sample kept to be reweighed later. The difference in weight was taken as a mass of the fat and was expressed as a percentage of the sample. Percentage oil content was regarded as percentage fat:

$$= \frac{w_2 - w_1}{w} \times 100$$

Where,

w = weight of original sample
w_1 = weight of empty flask
w_2 = weight of flask + extracted oil

Determination of crude fibre content

2g of each sample, added to 1g of asbestos were put into 20ml of 1.25% of H_2SO_4 and boiled for 30mins.The solution and the content were poured into a Buchner funnel equipped with muslin cloth and secured with elastic band. This was allowed to filter and the residue was put into 200ml boiled NaOH and the boiling allowed for 30mins after which, it was transferred to Buchner funnel and filtered. It was then washed twice with alcohol and the material obtained, washed three times with petroleum ether. The residue obtained was put in a clean dry crucible and dried in the moisture extraction oven to a constant weight. The difference in weight was calculated as the percentage of the original sample.

$$\text{Percentage crude fiber} = \frac{w_1 - w_2}{w} \times 100$$

Where,

w = weight of original sample
w_1 = weight of sample before incineration
w_2= weight of sample after incineration.

Determination of crude protein content

2g of each of the samples were mixed with 20ml of concentrated H_2SO_4 in a heating tube. One tablet of Selenium catalyst was heated inside a fume cupboard. The digest was transferred into 100ml distilled water. 10ml portion of the digest was mixed with equal volume of 45% NaOH solution and was poured into Kjeldaahl distillation apparatus. The mixture was then distilled and the distillate collected into 4% boric acid solution containing 3 drops double indicator (methyl red plus Bromocresol Blue indicators). A total of 50ml distillate was collected and titrated. The samples were duplicated and mean value taken. The Nitrogen content was calculated and multiplied by a constant, 6.25 to get crude protein content. This is calculated as percentage Nitrogen.

$$= \frac{T(A - B) \times 100 \times N \times 14 \times VF}{100 \times V_a}$$

Where,

N = Normality of the titrate (0.1N) HCl
VF = Total volume of the digest =100ml
T = Titre value (A= titre value of sample digest, B = titre value of blank)
V_a= Aliquot volume distilled

Determination of carbohydrate content

The carbohydrate content was calculated as the difference between 100 and the summation of other proximate parameters. Nitrogen Free Extract (NFE) Percentage carbohydrate is shown below

NFE = 100 – (moisture + protein + fat + ash + crude fibre)

Statistical Analysis

Results expressed as the mean $\pm$SD

RESULTS AND DISCUSSIONS

Table-1: Proximate/protein analysis

Constituents	Termites	Beef
Moisture	12.5 $\pm$0.025	22.5 $\pm$ 0.03
Ash	12.5 $\pm$ 0.03	15.0 $\pm$ 0.05
Lipid	20.0 $\pm$ 0.05	25.0 $\pm$ 0.05
Crude protein	10.06 $\pm$ 0.01	10.41 $\pm$ 0.001
Crude fibre	22.5 $\pm$ 0.03	25.75 $\pm$ 0.01
Carbohydrate	22.44 $\pm$ 0.01	1.34 $\pm$0.01

Values are means $\pm$ standard deviations of double determination

Proximate/Protein analysis

Table-1, which shows the proximate analysis of both beef and termites, revealed that both food sources are very rich in nutrients. Beef has more moisture (22.5 $\pm$ 0.003), ash (15.0 $\pm$ 0.05), lipid (25.0 $\pm$ 0.05), crude protein (10.41 $\pm$ 0.001), and crude fibre (25.75 $\pm$ 0.01) while termite contain more carbohydrate (1.34 $\pm$0.01), than beef which has (1.34 $\pm$ 0.07).

From the results, meat has the higher percentage moisture (22.5 $\pm$ 0.03), while termites have a lower percentage moisture of (12.5 $\pm$ 0.025). The high moisture content of meat is due to the fact that meat is composed of water, muscle, connective tissue, fat and bone. According to Ahmad *et al.*, [16] the high moisture content is the reason that meat cannot be stored for a long time.

There is a consensus among researchers that ash content of a given sample correlates with the mineral content of the sample. It stands to suggest that the two samples (termite and beef) studied here gives a fair source of minerals element as earlier reported by Ene [17]. This result suggests that both termites and beef contain a reasonable quantity of crude fibre, a substance which helps the body to maintain an internal distension for proper peristaltic movement of the intestinal tract. A low diet in fibre could lead to constipation which might bring discomfort to the body system and in some cases accompanied by running stool [18].

It was also observed that termites contain more carbohydrate than meat. This is not surprising given that their sources of food revolve around plant/humous materials. Timothy [8] reported that termites supply the body with more energy and iron than beef. It was also observed from the result that lipid content in meat was far more than that of termites. This may be as a result of too much fat naturally in meat which over consumption of it can be detrimental to health due to some lipid content (cholesterol) and saturated fat.

CONCLUSION

The search for alternative protein food source coupled with the ever increasing population and the cost of affording it, has become a serious challenge which must be overcome to prevent malnutrition and a cut to protein supply. From the research, it can be clearly seen that insects (termites) are highly nutritious, the difference in protein content of beef and termites is not much (10.41 $\pm$ 0.001 and 10.06 $\pm$ 0.01, respectively) which means termites can successfully replace beef in protein supply; and termites are even better than beef because they contain more carbohydrate than beef.

RECOMMENDATIONS

They should be more public enlightenment on the nutritious content of insects. Termites can be processed into flour because they have low moisture content and preserved for a long time and used for preparation of products like cookies, chocolates or even for cooking to encourage consumption. There should be commercial farming of insects since they are more nutritious than our local meat, require less resource for rearing and safer to our environment.

REFERENCES

1. Paoletti, M. G. & Dufour, D. I. (2005). Edible invertebrates among Amazonian Indians: a critical review of disappearing knowledge. *In*: M.G. Paoletti, ed. Ecological implications of mini live stock; role of rodents, frogs, snails, insects, for sustainable development, pp.293-342. New Hamphire, Science publishers.
2. Mbah, C. C., Emosairue, C. O., Builders, P. F., Isimi, C. Y., & Kunle, O. O. (2012). Effect of process parameters on the properties of some metronidazole tablet and capsule formulations. *African journal of pharmacy and pharmacology*, *6*(24), 1719-1725.
3. Widowson, W. G. (2004). *Soil formation termites.* Washington press, Washington, U.S.A.
4. Muyay,T. (1981). *Les insects comme aliments de l~homme :Serie 2, volume 69.Democratic Republic Of Congo*, Ceeba Publication.

5. Toledo, A., & Burlingame, B., (2006). Biodiversity and nutrition: a common path toward global security and sustainable development. *Journal of food composition and analysis,* 19: 477-483.
6. Adamolekun, B. (1993). Anaphe venata entomology and seasonal ataxic syndrome in south west Nigeria, Lancet, 341 (8845): 629.
7. De Foliart, G. (1992). The Human use of insects is a food resource: A Bibliographic Account in progress http// www.food-insects. Com/book
8. Timothy, J. B. (2016). *Survival of the creepiest*. Washington press, Washington, U.S.A.
9. Ademolu, K. O., Idowu, A. B., & Olatunde, G. O. (2010). Nutritional value assessment of variegated grasshopper, Zonocerus variegatus (L.)(Acridoidea: Pygomorphidae), during post-embryonic development. *African Entomology*, *18*(2), 360-364.
10. Ahmad, S. M., Birnin-Yauri, U. A., Bagudo, B. U., & Sahabi, D. M. (2013). Comparative Analysis on the Nutritional Values of Crayfish and Some Insects. *African journal of food science and technology*, *4*(1), 9-12.
11. Banjo, A. D., Lawal, O. A., & Adeyemi, A. I. (2006). The nutritional fauna of fourteen species of edible insects in Southwestern Nigeria. *African Journal of Biotechnology*, (3):298-301.
12. Malaisse. (1997). *Se nouir en foret Claire africaine approche ecologique et nutritionelle. Gembloux. Mccane, R. A.* (2004). *Phytic in huma*ns Nutrition. University of London press, England
13. Halton, T. L., & Hu, F. B. (2004). The effects of high proteindiets on thermogenesis, satiety and weight loss: a critical review. *Journal of the American College of Nutrition*, 23(5): 373- 385
14. Smeathman, H. (1781). Some account of the termites, which are found in Africa and other hot climates. In a letter from Mr. Henry Smeathman, of Clement's Inn, to Sir Joseph Banks, Bart. PR S. *Philosophical Transactions of the Royal society of London*, *71*, 139-192.
15. AOAC. (1990. Association of official Analytical chemist official method Analysis edited by Sidney Williams, AOAC lnc, Washington.
16. Ahmad, A., Mukherjee, P., Senapati, S., Mandal, D., Khan, M. I., Kumar, R., & Sastry, M. (2003). Extracellular biosynthesis of silver nanoparticles using the fungus Fusarium oxysporum. *Colloids and surfaces B: Biointerfaces*, *28*(4), 313-318.
17. Ene, J. J. (1963). Insects as food: A case study from the Northwest Amazon Am. *Anthropol*, 89:383-397.
18. Van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual review of entomology*, *58*, 563-583.