



Assessment of House Cricket (*Acheta domesticus*) Meal for Nigerian Households

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Abstract

Over 100 million people in Africa are affected by protein malnutrition because they cannot afford conventional animal protein. The light yellowish-brown cricket (*Acheta domesticus*) is one of the cricket species preferred for mass rearing. The study was aimed at assessing the safety of the house cricket meal for human and animals' consumption in Nigeria. Four house crickets were collected from the wild and reared in the animal house of Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria to produce several generations. Samples of adult and nymph house crickets were obtained from the stock and processed by sun-drying for three days and then analysed for microbial count. Samples of 10 g each were weighed and put in 90 ml of 4% tween 20 in 1 in 10 dilutions. Also, 10 ml was also measured aseptically and transferred to 90 ml of diluent in 1 in 100 bottle. The total aerobic microbial count for adult and nymph house cricket yielded growth with flat opaque colonies of *Bacillus* sp of 2430 cfu/g and 590cfu/g respectively. The mold count for the adult was 2470 cfu/g and 425 cfu/g for nymph respectively. House crickets sampled were free of disease-causing microbes such as *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens* and yeast.

Keywords: House cricket meal, Alternative protein, Safety, Mass production.

INTRODUCTION

Food security refers to the availability of safe, nutritious food that meets dietary requirements and preferences for an active and healthy life (Peng and Berry 2019). According to van der Mensbrugge *et al.* (2009), global food demand would double by 2050 as a result of population growth. Nigeria's current population exceeds 210 million, according to Worldometer's analysis of the most recent United Nations data (Worldometer, 2023). Nigeria faces a crisis in terms of food access and general food availability as a result of the observed substantial increases in the country's population. According to Owoo (2021), the number of people that are starved, not having adequate diet in Nigeria are about 14 million. This number also include children.

Increasing population inevitably increases food demand. (Tilman *et al.*, 2011). Although an extensive variety of food sources have been

developed, there are still no adequate sources of protein. According to Gavrilova (2020), the issue of guaranteeing the abundance of food products and their nutritious value is crucial to contemporary Nigerian. The population's diet is deficient in animal protein, which results in a number of health issues. Nigeria still has a high rate of malnutrition due to the drop in protein consumption brought on by high cost of sources of sources of protein such as milk, eggs, meat, and fish, resulting in an unbalanced diet and malnutrition (Asiabaka *et al.*, 1999; Das *et al.*, 2009; Obasi, 2003). Emerging strategies to combat this problem and identify effective remedies are the subject of global debate. Among these, insect farming for protein production is gaining popularity (van Huis *et al.*, 2013). In addition to its potential to aid in the fight against malnutrition and hidden hunger, this technique has the potential to improve global food security in specific regions (Manditsera *et al.*, 2018).

In most cultures, insects are considered to be traditional foods that are rich in nutrients and

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serve a significant part in human nutrition. In southwestern Nigeria, a significant fraction of the population consumes edible insects as part of their regular diet. These dried edible insects supply high-grade proteins and nutritional supplements minerals (Banjo *et al.*, 2006).

The majority of insects that people eat are inexpensive, abundant, and a good source of protein and minerals required to supplement cereal-based foods consumed in developing nations. Intriguingly, more than two billion people consume insects, contributing to a substantial amount of animal protein consumed in certain regions (Van Huis *et al.*, 2013). Protein, beneficial fats, vitamins, minerals, antioxidants, and prebiotic fibre are abundant in insects.

According to Imathiu (2020) and Baiano (2020), people in developing nations have a high apprehension regarding the safety of consuming insects as food because it forms part of their diet. Insects are vectors of disease-causing organisms which can harm both humans and animals (Kooch *et al.*, 2019). According to Dicke *et al.* (2020), even if the number of zoonotic illnesses that can be transmitted to people through edible insects appears to be limited, there is still a need for additional research to understand the potential dangers for food and feed. Two elements that could potentially raise issues for consumers regarding food safety are its many nutrients and antinutrient elements, which can also serve as optimal substrates for a diverse range of microbes to thrive (Aguilar-Toalá *et al.*, 2018). Scientific literatures has recorded cases of microbiological food-borne illnesses and intoxications originating from consuming insects, emphasizing the necessity of implementing effective good hygiene measures along the full value chain of edible insect foods to preserve the health of the consumers (Schabel, 2010; Garofalo *et al.*, 2017; Osimani *et al.*, 2017; Vandeweyer *et al.*, 2017). Banjo *et al.* (2006) also revealed that arthropods act as covert carriers or unwitting hosts for bacteria and fungus that can cause infections in man.

The accompanying microbes of insects may affect their suitability as food. The cleanliness of the substrate and surrounding environment, specifically the conditions of raising, has an impact on the existence of harmful microorganisms. Pathogenic microbes can be found in insects that are either picked from the wild or reared. These bacteria include *Campylobacter*, *Pseudomonas*, *Escherichia*, *Staphylococcus*, *Bacillus*, *Micrococcus*, etc. as

reported by Klunder *et al.* (2012); Vega and Kaya (2012); Rumpold and Schluter (2013); Grabowski and Klein (2017).

MATERIALS AND METHODS

Sample Collection

Two pairs of house crickets of both sexes obtained from the wild were reared to produce several generations in the constructed insect rooms at the animal house of Olabisi Onabanjo University Ago-Iwoye, Ogun State, Nigeria. Live adults and nymph house crickets weighing 500 g each were collected from the house cricket stock and samples were killed by freezing for 30 minutes, then blanched in boiled water, rinsed and drained in a sieve. The samples were spread on a stainless tray and covered with a lid with mesh to prevent flies' infestation during drying. The trays were placed in an open space for sun-drying for 3 days with temperature ranging between 31-33°C. House cricket samples were pulverized and analyzed by the College of Medicine, University of Lagos, Idi-Araba, in accordance with the International Commission on Microbiological Specifications for Foods, which assesses food safety and quality.

Microbiological Analysis

Using standard microbiological techniques as outlined by the AOAC (1995), *Escherichia coli*, total coliforms, *Staphylococcus spp.*, *Salmonella spp.*, *Shigella spp.*, *Bacillus cereus*, yeast, and mould counts in the house cricket meal were determined (Vanderzant and Splittstoesser, 1992). The results were contrasted with microbiological standards and recommendations, which provide guidance on the kinds of organisms and the number that can be deemed acceptable or harmful in food.

Agar Media Preparation

For preparation, all media were weighed in accordance with the Manufacturers' instructions. Before being autoclaved at 121°C for 15 minutes, the agar gels were first prepared by melting in a water bath and then being blended to prevent segregation.

Eosine methylene blue agar (EMBA): To make EMBA, the necessary 37.5 g was weighed out and added to a litre of distilled water. It was sterilised using an autoclave at 121°C for 15 minutes after melting at 100°C in a water bath. *Escherichia coli* would be identified and counted in the samples using agar.

Manitol salt agar: In order to make Mannitol Salt Agar, MSA, 111.02 g of the agar were dissolved in one litre of distilled water. It was melted in a water bath at 100°C to gelatinize it,

and it was then autoclaved at 121°C for 15 minutes. *Staphylococcus aureus* and additional *Staphylococcus* species would be counted if found using this agar.

Sabouraud dextrose agar: In order to make Sabouraud Dextrose Agar, 65 g of the agar were weighed in 1000 ml of distilled water. At 100°C, it was heated to melt in the water bath. The molten agar gel that had thusly created was autoclaved for 15 minutes at 121°C. This was employed for total counts of mould and yeast.

Tryptone soya agar: This was made by putting 40g in a litre of distilled water and stirring it. At 100°C, it was heated to melt in a water bath. It was thoroughly mixed before being autoclaved for 15 minutes at 121°C. For the total aerobic microbial count, this agar was utilised.

Reinforced Clostridial agar: In order to make reinforced clostridial agar, 52.5g of the agar was weighed in 1000ml of distilled water. At 100°C, it was heated to melt in the water bath. The molten agar gel that had thusly created was autoclaved for 15 minutes at 121°C. This was employed to identify and count *Clostridium perferingens*

DILUENTS PREPARATION

Tween 20 solution 4% was employed as the diluent. To get rid of any remaining chlorine action from the samples, 1 ml of 3% sodium thiosulphate was added to the 1 L preparation. The United States Pharmacopoea suggests using this polysorbate to dilute samples that may include natural antimicrobials and preservatives. It is also a good emulsifier, which improves mixing of samples that may include trace oils or be challenging to mix. To make the tween 20 solution, 40 ml of raw tween 20 was diluted into 1000 ml of distilled water.

SAMPLING

There were two working dilutions of the sample: one in ten (1 in 10) and one in one hundred (1 in 100) 90 ml of 4% tween 20 was added to a 10 g portion of the sample after it had been weighed. This dilution was one in ten (1 in 10). Aseptically measuring 10 ml, 90 ml of diluent were added to a 1 in 100 container. After shaking, 1 ml of each of the dilutions was aseptically transferred to petri plates with the necessary labels. 19 ml of sterile agar type was placed on top of them, and they were left to set. Plates were incubated at 37°C and monitored every day for 72 hours to determine the bacterial load. For seven days, the fungal load test plates were incubated at 25°C and

monitored every day. The diluent used was 4% tween 20, a polysorbate that could emulsify the sample and render it incapable of acting as an antibacterial.

RESULTS AND DISCUSSION

The result from tables 1 and 2 shows that the total aerobic microbial count for 1/10 and 1/100 dilution yielded growth with flat opaque colonies of *Bacillus* of 2260 cfu/g and 2600 cfu/g for adult house cricket and 580 cfu/g and 600 cfu/g for nymph respectively. Eosine Methylene Blue Agar (EMBA) yielded moldy growth of *Mucor spp* of 2620 cfu/g and 1350 cfu/g in 1/10 and 1/100 dilution in adult sample and 550 cfu/g in both 1/10 and 1/100 dilution of nymph sample respectively. *Escherichia coli* was not seen in both adult and nymph samples. Manitol Salt Agar (MSA) was used to identify and also count the number of *Staphylococcus aureus* and other species of *Staphylococcus* yielded 620 cfu/g and 525 cfu/g of moldy growth of *Bacillus* and *Mucor spp* in 1/10 and 1/100 dilution for adult house cricket 1550 cfu/g and 1650 cfu/g for nymph respectively. There was no presence of *Staphylococcus aureus* in the two samples.

Reinforced Clostridial Agar (RCA) plates yielded moldy growth of 2340 cfu/g and 2550 cfu/g for adult samples in 1/10 and 1/100 dilution as well as 400 cfu/g and 600 cfu/g for nymph sample respectively. *Clostridia* was not seen in both house cricket samples.

Sabouraud dextrose agar (SDA) was used for total yeast and mold counts yielded 1340 cfu/g and 3600 cfu/g moldy growths, *Mucor spp* in 1/10 and 1/100 dilutions for adult house cricket and of 300 cfu/g and 550 cfu/g for nymph sample respectively. No yeast was seen in both adult and nymph house cricket.

Table 1: Microbial Plate count of Adult house cricket powder (cfu/g)¹

Assay	Dilution		Morphological characteristics of microbial isolates
	1/10	1/100	
TSA	2260	2600	Plates yielded growth with flat opaque colonies with rough edges of <i>Bacillus</i>
EMBA	2620	1350	No greenish metallic sheen growth <i>Escherichia coli</i> not seen
MSA	620	525	No yellowish colonies growth detected. No <i>Staphylococcus aureus</i> seen
RCA	2340	2550	No whitish colonies growth detected. <i>Clostridia</i> not seen
SDA	1340	3600	Plates yielded greyish brown colonies of <i>mucor</i> spp. No yeast seen

TSA: Tryptone soya agar; EMBA: Eosine methylene blue agar; MSA: Manitol salt agar; SDA: Sabouraud dextrose agar; RCA:

Reinforced clostridial agar; cfu/g: Colony Forming Unit Per Gram

Table 2: Microbial plate count of nymph house cricket powder (cfu/g)

Assay	Dilution		Morphological characteristics of microbial isolates
	1/10	1/100	
TSA	580	600	Plates yielded growth with flat opaque colonies with rough edges of <i>Bacillus</i>
EMBA	550	550	No greenish metallic sheen growth. <i>Escherichia coli</i> not seen
MSA	1550	1650	No yellowish colonies growth detected. . No <i>Staphylococcus aureus</i> seen
RCA	400	600	No whitish colonies growth detected . <i>Clostridia</i> not seen
SDA	300	550	Plates yielded greyish brown colonies of mucor spp. No yeast seen

TSA: Tryptone soya agar; EMBA: Eosine methylene blue agar; MSA: Manitol salt agar; SDA: Sabouraud dextrose agar; RCA:Reinforced clostridial agar; cfu/g: Colony Forming Unit Per Gram

The average biomass of microbial loads for adult and nymph house cricket is shown in table 3. Adult and nymph house cricket have 2340 cfu/g and 590 cfu/g in TSA, 1985 cfu/g and 550 cfu/g in EMBA, 835 cfu/g and 1600 cfu/g in MSA, 2445 cfu/g and 500 cfu/g in RCA and 2470 cfu/g and 425 cfu/g in SDA respectively. The result from this study shows that adult house crickets have higher load of *Bacillus* and molds in all the media except in Manitor Salt agar (MSA) where the nymph plates yielded higher value of 1600 cfu/g than the adult (835 cfu/g).

Table 3: Average biomass of microbial loads of adult and nymph house cricket

Assay media	Adult	Nymph
TSA	2430	590
EMBA	1985	550
MSA	835	1600
RCA	2445	500
SDA	2470	425

TSA: Tryptone soya agar; EMBA: Eosine methylene blue agar; MSA: Manitol salt agar; SDA: Sabouraud dextrose agar; RCA: Reinforced clostridial agar; cfu/g: Colony Forming Unit Per Gram

Table 4 below shows the ICMSF official limit for Good Manufacturing Practices (GMP) and maximum value for microbial parameter.

Table 4: Microbial Limit Report of adult and nymph House Cricket (cfu/g)

Microbial parameter	Average parametric count for adult cricket	Average parametric count for nymph cricket	ICMSF official limit	
			Gmp	Max. Value
Total plate count	2430	590	<10 ⁴	10 ⁶
<i>Staphylococcus aureus</i>	ND	ND	<10 ²	10 ⁴
<i>Bacillus cereus</i>	ND	ND	<10 ⁴	10 ⁴
<i>Clostridium perfringens</i>	ND	ND	<10 ²	10 ³
<i>Escherichia coli</i>	ND	ND	<10 ²	10 ³
Yeasts	ND	ND	<10 ³	10 ⁵
Molds	2470	425	<10 ³	10 ⁵

cfu/g: Colony Forming Unit Per Gram; ND: Not detected

This study reveals a total aerobic microbial count for adult and nymph house cricket yielded growth with flat opaque colonies of *Bacillus* sp of 2430 cfu/g and 590 cfu/g respectively. This is below ICMSF official limit Gmp of ($<10^4$ cfu/g) and maximum value of ($<10^6$ cfu/g). The mold count for the adult was 2470 cfu/g and 425 cfu/g for nymph respectively. The values recorded for adult house cricket is higher than the minimum limits but less than the maximum limits. The higher value for mold count could be due to the method of drying (sun-drying) which may not be sufficient enough to prevent mold growth. The elevated mould count aligns with the results reported by Megido *et al.* (2017), which demonstrated that the yeast and mould count in crickets exceeded the limits set by GMP for uncooked meat. Nonetheless, this count was brought down to acceptable GMP levels by the blanching method.

The findings of this study indicate that house crickets raised in a regulated setting were devoid of *Clostridium perfringens*. This discovery aligns with the findings reported by Osimani *et al.* (2017) that *Clostridium perfringens* and other sulfite-reducing clostridia have been infrequently observed or were present at low numbers (10^2 cfu/g).

The presence of *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, and yeast was not observed in this investigation. Contrary to the findings of Klunder *et al.* (2012), Vega & Kaya (2012), Rumpold and Schluter (2013), and Grabowski and Klein (2017), which identified *Staphylococcus*, *Bacillus*, *Campylobacter*, *Pseudomonas*, *Micrococcus*, *Acinetobacter*, *Proteus*, *Escherichia*, Enterobacteriaceae, and other spore-forming bacteria, as well as viruses, fungi, and protozoa in edible insects. Vandeweyer *et al.* (2017, 2018) found that the composition of microbial communities is regulated by the settings in which the organisms are raised. These communities are particularly affected by factors such as the manipulation of the organisms by breeders, as well as the microbiota present in their food and water. Grabowski and Klein (2017) documented the absence of *Salmonellae*, *Listeria monocytogenes*, *E. coli*, and *Staphylococcus aureus* in various cooked and processed edible insects, including those that were deep-fried. This finding has shown that house cricket reared in a controlled environment under hygienic condition will be free of disease-causing microbes and will be safe for

consumption. This aligns with the findings of Klunder *et al.* (2012) that potential microbial risks in insect farming can be reduced by maintaining hygienic procedures and safe insect food sources.

CONCLUSION

The safety of edible insects lies in the procedures through which it is reared and processed as meal. The result in this study shows that house crickets reared and sun-dried in a controlled environment was free of disease-causing microbes such as *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium perfringens*, and *Yeast*. This is an indication that house cricket could be free of microbes and safe for consumption.

RECOMMENDATION

From this study, it is recommended that effective drying method should be employed in order to reduce or keep molds away completely from edible insects. House cricket meal should go through cooking process before consumption in addition to good hygiene practice during its preparation as meal. Based on the above findings, house cricket consumption will be safe for Nigerian households.

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