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BOOK REVIEW

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Book review: African edible insects as alternative source of food, oil, protein and bioactive components

Edited by: Abdalbasit Adam Mariod

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The book has a total of twenty two chapters covering commonly consumed African edible insects and their nutritional composition, history and economic importance. The book is edited by a scientist and expert in food science and technology, oil chemistry, functional foods and bioactive compounds. To support the discussions in the chapters, the authors have used tables, figures and photos. The book delves directly into chapter one and lacks a preface by the editor introducing the contents of the book.

The first chapter of the book discusses the importance of insects as food in Africa. This chapter delineates major insects harvested for food in Africa and the opportunities for semi-domestication and full domestication of edible insects such as palm weevil and crickets, respectively. The author indicates that 472 insect species are consumed in Africa with caterpillars, locust, grasshoppers and crickets leading in consumption, while termites are largest in diversity. The author, however, notes that several locusts and grasshopper species and the fall armyworm being consumed as food are equally very destructive pests. The author further discusses edible insects' economic importance, their contribution to food security, insects as feed ingredient, farming systems, nutritional components, processing (largely by drying, frying, smoking, boiling) and marketing.

The second chapter focuses on African edible insect consumption market. The authors define insect consumption as the business of promoting, producing, buying and selling edible insects and their products and other beneficial services obtained from insects. Preservation of natural habitats is key while mass rearing appears promising in production. The insect market groups the insects according to kind, product type and use. Similar to the previous chapter, the species, consumption and diversity of edible insects' in Africa have been discussed. The authors note that value and pricing of insects fluctuate based on several factors such as harvesting season, consumer's attitude, time spent harvesting, insect type and location. However, a rising trend in the value of the insects trade was noted. This chapter further discusses the edible insect value chain such as input supply, production, processing, marketing and consumption. Activities and challenges as well as female or male participation in each step of value chain have been discussed. The chapter, however, does not capture service provision such as transportation, credit, and training along the value chain. The authors conclude by noting that the supply of insects is low compared to the high demand and thus an equilibrium needs to be reached through increased production awareness creation and marketing.

The third chapter describes the history, benefits and disadvantages of entomophagy in Africa. The term entomophagy is defined as the practice of eating insects by humans. The chapter proceeds to give the history of the insects and benefits of consuming insects such as income, food security, pest invasion control and low environmental impact. Toxicity, spoilage and allergic reaction were noted as key disadvantages of entomophagy and care should be taken during processing.

In chapter four, the author discusses the microbiology of African edible insects. The author notes the presence of micro- and mycobiome during the transition from production to consumption of edible insects. Some species of the micro- and mycobiome are common in most insects, while their abundance varies depending on insects' stage, locality, study methods and recontamination after harvesting. Processing of insects may reduce the microbial count. The chapter summarizes the microbial content of some commonly consumed insects and notes that farming insects could introduce certain microbial species that could be absent in insects' natural habitats. Good hygienic practices during handling and processing would promote safety but may affect the taste and nutritional composition of the product. Processing methods such as milling of insects was found to increase the microbial count and decries that preservation techniques such as fermentation have not been exploited on edible insects.

Chapter five dealing with food safety of edible insects gives a summary of possible microbial, chemical and toxicological hazards. The authors discuss heavy metals, pesticides, mycotoxins, antinutritive factors and pathogens as major contaminants in insects. The chapter, however, notes the dearth of scientific information on microbial contamination during processing. The author discusses food safety regulations from a global perspective, stressing that good hygiene during processing could mitigate transmission. Moulds and mycotoxins were found to infect insects via feed which could be contagious to humans. Other risks discussed are toxicity, parasites, allergens, metals and organic pollutants and physical hazards. The chapter concludes that edible insect species have no more hazards than other animal food products, and insects can be regarded as safe when they are properly managed and consumed.

Chapter six is on interdisciplinary uses of some edible insect species. The chapter introduces the commonly beneficial insects in Africa as food, food ingredients (food colouring), and medicinal purposes. The authors discuss the nutrients, fatty acid, vitamins and mineral composition of some edible insects. They further discuss in details use of insects as a source of protein isolates, oil, and bioactive components that maybe be important in reducing health risks and strengthening the immune system. The chapter, however, cautions that further research is needed to ascertain health claims.

Chapter seven is on the sensory quality of edible insects. Like several previous chapters, the authors detail the nutritional aspects of edible insects and their safety and give a global perspective on consumption. Similar to previous chapters, the authors discuss the proteins and amino acids, fatty acid composition, micronutrients, minerals, vitamins, fibre and energy content of some insects consumed. The title, however, does not reflect the contents in the chapter. The book would have benefited more if content of the chapter was combined with chapter 6, and have chapter 7 review the sensory attributes of edible insects. Several authors have published studies on sensory and consumer acceptability of insects that may have been reviewed as part of the chapter (Alemu *et al.*, 2016; Caparros Megido *et al.*, 2014; Cayot *et al.*, 2009; Kinyuru *et al.*, 2009; Kouřimská and Adámková, 2016; Mishyna *et al.*, 2019; Pambo *et al.*, 2018; Schouteten *et al.*, 2016).

The eighth chapter discusses the automation of insect mass rearing and processing technologies of mealworms (*Tenebrio molitor*) of production volumes of at least one tonne per day. This chapter is rich on the automated separation of larvae from frass, and monitoring process of mealworms using zigzag air separator and integrated camera system with artificial neural network classifiers (ANN classifiers), respectively. The unit operations from production to processing and optimum rearing requirements are detailed in the chapter. Technical processes for drying and defatting of the mealworms are also detailed with optimization processes discussed. This is because the nutritional value and quality of the larvae are highly affected by temperatures and time taken during processing.

Chapter nine focuses on the legislative status of edible insects globally. In many countries, the author notes a lack of legal and policy frameworks that enable utilization of insects as food and feed. Though the chapter has discussed the legislative status and on-going efforts in western and Asian countries, it does not discuss the similar efforts in Africa which a key focus of the book. Efforts have been done to develop national standards guiding the use of insects as food and feed in some African countries such as Kenya and Uganda (Fiaboe and Nakimbugwe, 2017; Kinyuru and Ndung'u, 2020).

The tenth and eleventh chapter is on sorghum bug (*Agonoscelis pubescens*) and watermelon bug (*Aspongopus viduatus*) as a source of edible oil, protein, and gelatin. The chapters discuss in depth the oil extraction and composition, oxidative stability of the oil and its stability during processing e.g. when used in deep frying. The insects as sources of protein and gelatin are also discussed. Non-food uses of insects such as production bio-diesel and animal feed are also discussed. The authors, however, note that advanced processing techniques are needed to provide readily available products that are primarily insect-based with a prolonged life.

Chapters 12 to 22 focuses on the nutritional composition and bioactive compounds of edible insects with each chapter discussing a specific edible insect. The chapters emphasize the high nutrient content and quality of each insect compared to conventional foods and the presence of other beneficial bioactive compounds. Chapter 12 discusses the African edible acridians namely *Zonocerus variegatus*, *Kraussaria angulifera*, *Acanthacris ruficornis citrina*, *Locusta migratoria*, *Cyrtacanthacris aeruginosus unicolor*, *Schistocerca gregaria* and *Anacridium melanorhodon*. The acridians discussed have high protein content, polyunsaturated fatty acids, vitamins and minerals. The authors also discussed the effect of cooking on these nutrients. The authors, however, report that harmful heavy metals such as lead have been detected in some acridians though the content is below the dangerous limits.

Chapter thirteen gives attention to the nutrient content of the black soldier fly (*Hermetia illucens*) (BSF). The author notes that the insect is highly digestible as a feed with high protein, high in fat majorly saturated and followed by monounsaturated fat. The effect of the BSF feed on livestock is discussed as well as safety and legal issues surrounding its use. Chapter 14 details nutritional and bioactive components of crickets (*Gryllidae*), while chapters 15, 16, and 17 have an in-depth view of the nutritional composition and bioactive components of the ant *Oecophylla smaragdina*, the migratory locust *Locusta migratoria* and the mopane worm *Gonimbrasia belina*, respectively.

Chapter eighteen discusses the desert locust (*S. gregaria*) nutrient composition while chapter nineteen focuses on the nutrient composition of the brood and adult workers of the Asian honeybee species *Apis cerana* and *Apis dorsata* and how the composition differs between species. Chapter twenty discusses the nutrient composition of mealworm (*T. molitor*). Chapter twenty one expounds on the nutrient composition of termites but unlike the preceding chapters, the author's gives the economic importance, harvesting and processing and medicinal value of various termite species. Chapter twenty specifically discusses the nutritional profile of termites consumed by local communities in Ethiopia. The authors genetically identify three species of the genus *Macrotermes* namely *Macrotermes falciger*, *Macrotermes herus* and *Macrotermes jeanneli* and relate the termite's nutritional profile to human nutritional needs. The authors denote that nutrients are relatively high and thus may help mitigate some widespread deficiencies

Overall, the book offers a wide overview of the edible insects in the African context. Some chapters close with conclusions including recommendations for future research and innovation. However, there is a lot of overlap and repetitions between several chapters needing more editorial scrutiny in future editions. This book is a valuable and timely resource for all actors in the edible insect industry.

The book, therefore, would serve as a reliable reference volume on edible insects.

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