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Review

Nutritious food and health risks: a review on the edible land snails of Africa

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ABSTRACT

Snail meat is a source of food and livelihood for many inhabitants especially in sub-Saharan Africa. They are consumed in households or traded at local and international markets. However, African land snails are rarely farmed but picked from environments that include decaying vegetation, soil debris, and untreated human and household wastes. These 'snail natural habitats' may contain microbial pathogens that could easily be ingested by snails and transmitted to snail meat handlers and consumers. The objective of this study was to investigate published information that establishes the local consumption practices of African land snails as a credible source of foodborne infections. Acknowledging the nutritional benefits of consuming snails, this research revealed local practices in snail gathering, handling, preparation and preservation could significantly contribute to food-related disease burdens to Africans and several African snail meat-exporting countries. With this, national and international food safety regulations are required for African snail meat consumption.

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1. Introduction

Edible land snails are defined by regulation (EC) No. 853/2004, as terrestrial gastropods of the species *Helix pomatia Linné, Helix aspersa Muller, Helix lucorum* and the *Achatinidae* family (1).

While *Helix species* remain a delicacy in many European cuisines, species of the Achatinidae family precisely *Achatina achatina, Achatina fulica* and *Archachatina marginata* are popularly consumed in the tropical rainforest and savannah zones of Africa (1-6).

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A mature African land snail ranges between 3-25 cm and could weigh up to 600 g (2). It is characterised by dark brown with dark stripes and streaks or reddish-brown with pale yellow vertical markings running across seven to nine whorls (2). Its meat is tender and chewy, with a unique pleasant floral-like, mushroom-like flavour (3).

With technological limitations in crop production and an increase in the prices of conventional meat (such as beef, chicken and pork) in African local markets, snail meat has become a principal protein food for the rural people (2,4-6). In Ivory Coast, an estimated 7.9 million kilograms of snail meat is consumed annually, and demand currently outstrips supply in Ghana, Cameroon, and Nigeria (2,4-8). Internationally, African snail species fetch about one-third the price of European *Helix* species leading to hundreds of millions of US dollars' worth of African snail meat exported annually (2). The Taiwanese, specifically offer tinned *Achatina fulica* for sale in Taiwan and China, and *A. fulica* is a local food source in Seoul, Korea (2).

Despite its high and inexhaustible demand in restaurants, hotels, street food industry, food festivals and foreign markets, snail farming or heliciculture hardly exist in Africa (2,8). Land snails are handpicked for sales and domestic consumption. Traditionally, rural folks (including women and children) scout freely in villages and towns, in search of snails in damp and humid jungles (tropical rainforest), farm clearing, roadsides, footpaths, and backyards (2,4,9). In such 'natural habitats' characterized as 'filth', 'sewage', 'manure' and 'rotten materials' (10), microbial pathogens causing little or no effects on edible snails are inevitable (4,10). Foodborne pathogens could easily be ingested by live snails, or retained in their bodies, and transmitted to humans during handling and/or consumption, thereby causing food-related illnesses (4,10,11). Previous studies have enumerated important microbial pathogens in farmed snails which are sold in local markets across Africa (4,5,10).

In addition, health risks in snail handling and consumption that could contribute to foodborne disease burdens in Africa have been significantly overlooked. For example, no recorded food-related disease prevalence has been attributed to snail meat consumption despite documented research on snail-microbial pathogen association. Evidence-based practices and subsequent interventions to target foodborne health risk factors in snail meat consumption are limited. It is uncertain if snail meat handlers and consumers are potentially exposed to food safety risks and limiting the probability that snail meat consumption practices could negatively affect their health and wellbeing is a massive risk to public health. The objective of this paper was to critically investigate the nutritional importance of African land snails. It also emphasizes snail-associated microbial pathogens which provide evidence of the public health risks in handling and/or consuming contaminated African land snails. This review focused on publications between January 1995 and February 2022 in Scopus, Web of Science, PubMed, Science Direct, Directory of open access journals and JSTOR databases.

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2. African land snails – a nutritive source of food

Malnutrition is one of the most devastating problems facing developing countries. Each year, malnutrition registers about 49% out of 10.7 million deaths in children under the age of five (12). Vitamin A deficiency remains the greatest preventable cause of needless childhood blindness, and the lack of Iodine is the greatest cause of brain damage and mental retardation (12). To reduce the adverse effects of protein-energy malnutrition among the vulnerable groups (children, pregnant women, and aged persons), African land snails are recommended as good substitutes for meat protein. For example, powdered snail meat enriched foods are fed to breastmilk-weaned babies (13). Snail meat substitute is particularly encouraged in rural communities such as Cameroon and Nigeria, where more than 80% of its population are unable to afford conventional meat products (5,6,13). Chemical compositions show a snail meat diet is balanced for a healthy body, as it contains the required amount of protein, carbohydrates, fats, minerals, and vitamins.

2.1. Proximate composition

The proximate composition of the most consumed African land snails is presented in Table 1. Snail meat is richer in protein (37-51%) than guinea pig (20.3%), poultry (18.3%), fish (18%), cattle (17.5%), sheep (16.4%) and swine (14.5%) (5). Ugwoke and Gadzama (2018) confirmed that the dried flesh of African giant snails - Archachatina marginata var. saturalis (protein content - 86.96±0.37%) is richer in protein than tropical periwinkle - Tympanotonus fuscatus var. radula (protein content - 25.96±0.56%) (14). During digestion, different amino acids which make up snail proteins are broken down for the building and repair of body tissues. Specifically, Adeyeye and Afolabi (2004) reported that African land snails contain essential amino acids of 45.0-361 mg/g crude protein (with histidine) and 4.3-331 mg/g crude protein (without histidine) (15). With lysine (5.7-8.3 g/100 g protein) as the dominant essential amino acid, glutamic acid (11.1-14.1 g/100 g protein) remains the most abundant non-essential amino acid in land snails (15,16). Thus, the consumption of lysine-deficient plant-based cereals could be complemented with snail meat.

On the other hand, African land snails are relatively low in fats, carbohydrates, and cholesterol. These low values are expected as the extremely slow nature of snail movement only needs to store small amounts of carbohydrates in the form of glycogen (13). It should be noted that glycogen is generally converted into fats. Fat contents in African land snails lie between 0.96-3.0% and are relatively lower than in chicken (9.6%), eggs (21.4%) and mutton (23.0%) (5,16). It's lipid factions mainly consist of polyunsaturated fatty acids (57%), saturated fatty acids (23.25%) and monounsaturated fatty acids (15.5%) (16,17). Polyunsaturated fatty acids consist of n-3 to n-6 (more n-3 and less n-6) and dominate in linoleic and eicosadienoic acids. These unsaturated fatty acids play protective roles in cardiovascular and inflammatory diseases, lupus, diabetes, psoriasis, obesity, Crohn's disease, rheumatoid arthritis, and cystic fibrosis (13,16,18). Saturated fatty acids on its part are undesirable due to linkages with atherosclerotic disorders (13,16,18). This indicates land snails are more beneficial in human diets

than many conventional meat products which contain excessive saturated fatty acids (16,18,25).

2.2. Mineral composition

The edible portion of African land snails is made up of 30% minerals. These minerals mainly consist of calcium, phosphorus, iron, zinc, copper, magnesium, manganese, cobalt, and iodine (Table 2). Calcium is the most abundant at 650-700 mg/100 g (13,16). It is essential for the normal clotting of blood, and traditionally, the visceral fluid of land snails is used to stop wounds from bleeding (13). Consumption of 100 g of dried snail meat could provide the daily requirement of zinc (RDA for adults is 15 mg) in the human body (13). Iron in *A. fulica* (55-56 g/100 g), *A. marginata* (40.00 g/100 g) and *A achatina* (41.11g/100 g) are beneficial in treating anaemic conditions (5,13). Notably, copper content of 9.72-16.15 mg/100 g places snails meat at the first position among animal food sources containing haemocyanin (13,18). Haemocyanin is a protein containing copper that is essential for the transportation of oxygen into the blood plasma, in iron metabolism, neuropeptide activation, and connective tissue synthesis. Potassium in land snails on its part profoundly affects the excitability of the nervous tissue (18). It influences the contractility of smooth, skeletal, and cardiac muscles, and these mechanisms are traditionally used to facilitate stages in labour and childbirth (13). The presence of phosphorus in snail meat reduces hypophosphatemia and provides anti-rheumatic effects (13,18,25). These effects are characterized by loss of appetite, anaemia, muscle weakness, bone pain, rickets (in children), osteomalacia (in adults), increased susceptibility to infection, difficulty in walking, numbness and tingling of the extremities (13,18).

However, the above-mentioned minerals are interrelated and do not play independent self-sufficient roles in the human body. For instance, calcium and phosphorus are involved in the formation of bones and teeth. Iron and zinc reduce the morbidity of diarrhoeal diseases and pneumonia (13).

Finally, the nutritional composition of African land snails has been reported to depend on their free-living environment and feed constituents. For instance, while comparing with, Edidiong et al. (2016) reported higher proximate composition including moisture (69.7%), ash (9.39%), fibre (6.11%), protein (60.56%), lipid (5.67%) and carbohydrate (18.25%) in snails collected from shellfish producing areas, Akwa Ibom state, Nigeria, (26). Ademolu et al. (2004) reported an increase in crude protein (87.94%) when nitrogen-sourced feeds (soybean, fishmeal, poultry droppings, and urea) constituted *A. marginata* diets (27). Tchakounte et al. (2019) recorded a significant increase in crude protein: 45.85%, 50.52%, 55.22% and 57.30% when calcium levels of *A. marginata* were increased from 12% 14%, 16% to 18% respectively (28).

With these nutritional qualities, African land snails represent good substitutes to several foods consumed, specifically in Africa.

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Table 1. Proximate composition of the most consumed African land snails*

Land snails	Moisture (%)	Protein (%)	Carbohydrates (%)	Fats (%)	Fibre (%)	Ash (%)	Reference
Achatina fulica	4.88±0.01	62.56±1.23	27.29±1.21	2.27±0.16	0.03±0.01	3±0.01	(19)
	73.37±1.91	19.49±2.41	6.00±1.93	4.63±1.62	0.42±0.42	2.98±1.06	(20)
	83.80	83.13	NA	8.70	NA	8.90	(21)
	79.28	10.08	NA	1.61	NA	1.78	(22)
Achatina achatina	73.72±3.28	20.03±3.50	4.42±1.66	3.85±1.09	0.63±0.57	3.47±1.14	(20)
	6.1±0.01	71.66±1.24	13.69±0.15	5.06±0.14	1.21±0.03	3.49±0.01	(19)
	84.44	15.63	NA	2.20	0.14	4.08	(23)
	83.30	65.65	NA	11.90	NA	4.00	(21)
	75.28	17.20	NA	2.21	NA	2.33	(22)
	77.54±0.02	19.27±0.29	0.42±0.30	1.43±0.01	-	1.34±0.02	(24)
Archachatina marginata	5.2±0.05	85.12±2.14	2.25±0.11	4.37±0.06	1.32±0.15	3.06±0.02	(19)
	73.69	19.53	NA	2.44	NA	2.56	(22)
	73.14	12.85	NA	2.57	0.25	7.41	(19)
	73.65±2.43	18.83±2.65	6.13±2.68	4.40±2.37	0.36±0.49	2.90±1.05	(20)
	80.90	78.75	NA	7.65	NA	6.50	(21)

* Values are expressed on a dry matter basis and as mean ± standard deviation, NA denotes Not Available

Table 2. Mineral composition of the most consumed African land snails**

Land snails	Na	Ca	K	Mg	P	Zn	Fe	Mn	Cu	Reference
A. fulica	73.38±0.27	402.29±5.18	111.02±0.3	301.2±0.33	61.29±11.34	5.81±0.1	26.64±0.26	1.29	3.83±0.08	(19)
	80.28	116.43	NA	64.19	103.34	0.50	55.56	18.34	16.15	(21)
A. achatina	79.00	1112.86	NA	63.35	100.00	0.79	41.11	14.45	9.72	(21)
	58.090±.12	656.9±5.46	114.65±0.44	304.62±0.19	241.9±11.3	6.28±0.1	5.75±0.05	0.17±0.03	0.73±0.02	(19)
	NA	316.67	NA	12.00	176.33	1.19	0.30	NA	0.57	(24)
A. marginata	67.64±0.19	701.79±4.32	111.43±0.46	308.7±0.42	268.53±5.34	8.41±0.12	6.33±0.05	0.73±0.04	0.98±0.03	(19)
	NA	316.67	NA	24.00	166.00	1.24	0.35	NA	0.61	(24)
	81.80	126.43	NA	1611.15	103.34	0.46	40.00	35.56	11.72	(21)

** Values are expressed in mg/100 g and mean ± standard deviation, NA- Not Available

3. Microbial contamination in African snail meat consumption

Typical in developing countries, the street food industry and local markets are largely involved in the sale and consumption of foods. While local food markets incorporate live or slaughtered animals, raw and fresh food products, the street food industry trades large proportions of ready-to-eat foods. They are characterized by informal overcrowded settings with little or no infrastructure (29), and vending activities are affected by weather conditions, that is, wet and muddy in the rainy seasons or dusty in the dry seasons.

These two settings provide affordable food to many low-income individuals - the poor. It is an important source of livelihood for millions of urban and rural dwellers and low-income groups depend on these foods due to their relatively low prices and conveniences rather than their quality, safety and hygiene (30).

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Table 3. Potential microbial pathogens in edible portions of African land snails

Sampling location (s)	Microbial pathogens	Authors' remarks	Reference
Meat, Nwofe, Eke-Aba, Iboko markets in Abakaliki, Nigeria	*E. coli, Pseudomonas* spp., *Shigella* spp., *Enterobacter* spp., *Salmonella* spp. and *Klebsiella* spp.	Snail contamination occur during sales through poor handling in open markets, thus adequate preparation is needed to avoid epidemic threats.	(34)
Creek Road, Mile one, Rumuokoro markets in Port Harcourt, Nigeria	*Vibrio* spp., *Bacillus* spp., *Staphylococcus* spp., *Shigella* spp., *Pseudomonas* spp., *Enterobacter* spp., *E. coli, Micrococcus* spp., *Acinetobacter* spp., *Klebsiella* spp., *Listeria* spp. *Salmonella* spp. *(S. arizonae, S. gallinarum* and *S. typhi*)	*Salmonella spp.* is susceptible to Ofloxacin and Ciprofloxacin and strongly resistance to Cetazidime and Gentamicin. The presence of diverse and elevated microbial loads calls for caution in snail handling and processing.	(35)
Markets and farms in Greater Accra, Ghana	*Salmonella* spp., *Staphylococcus* spp., *Bacillus* spp. and *Pseudomonas* spp.	Deshelling, slime removal, unpackaging are problems associated with snail meat.	(4)
Five snail farms in Warri and Sapele, Delta state, Nigeria	*Salmonella* spp., *Bacillus* spp., *Pseudomonas* spp., *Staphylococcus* spp., *Klebsiella* spp., *E. coli.*	All organisms are resistant to Chloramphenicol and Ampicillin. Microbial counts may increase under unhygienic conditions leading to health risks	(10)
Itam, Akpan Andem, Afaha, Ikpa markets in Uyo, Nigeria	*Salmonella* spp., *Vibrio* spp. and *Escherichia coli*	Snail handlers and consumers need to take responsibility to prevent cross-contamination, mishandling, improper cooking, and storage of snail meat	(36)
Markets and road junctions in Cross river and Akwa Ibom states, Nigeria	*Salmonella* spp., *Shigella* spp., *Aeromonas* spp., *Vibrio* spp., *Pseudomonas* spp., *Enterobacter* spp., *Klebsiella* spp., *Staphylococcus* spp., *Yersinia* spp.	Bacterial isolates showed multi-drug resistance to antimicrobials, thus a need for proper processing of snails.	(37)
Uyo, Itam, Akpan, Andem markets in Uyo, Akwa Ibom State, Nigeria.	*Bacillus subtilis, Staphylococcus aureus, Lactobacillus* spp., *Escherichia coli, Micrococcus luteus, Bacillus cereus*	Although nutritionally rich, snails are reservoirs of pathogenic microorganisms of importance to public health.	(17)

The greatest challenge in handling and consuming food in traditional settings is inadequate knowledge of proper food safety practices (29-31). For example, the washing of hands, utensils, and dishes is often done in buckets or bowls due to limited washing facilities (29). Food is inadequately protected from flies and refrigeration is usually unavailable (29,30). Microbial contamination could easily arise from the raw materials used, the place of preparation, utensils used in cooking and serving, and the personal hygiene of vendors (29). In an era of COVID-19, additional measures for crowd control, physical distancing, hand washing, sanitization and education on respiratory hygiene (example, the use of face masks) should be introduced in local market settings (32). Unfortunately, these actions hardly exist in typical African food markets.

This research incorporated the above-mentioned food consumption and vending contexts to highlight African land snails-associated microbial pathogens vis-à-vis 1) snail gathering and transportation, 2) snail meat handling, preparation, and vending, and 3) snail meat preservation.

3.1. Snail gathering and transportation

Snail gathering in the rainforest belt varies with gathering locations (for example, bushes, forests, farmlands and/or footpaths) and weather conditions, that is, after heavy downpours at night (2,5,9). On a rainy night between the hours of 9 pm to 5 am, rural inhabitants use torches to search for snails in backyards, farms, and plantations. Gatherers may spend up to twenty hours a week in search of snails in both protected and unprotected areas (8,33). During the day, snails can be collected in dark and damp areas such as underneath farm clearing and decaying vegetation (4,9). Snails are picked by hand when actively feeding or moving about and put in old bags/buckets for transportation (2). Nyoagbe et al. (2016) and Kaldjob et al. (2019) respectively reported consumers in Ghana and Cameroon will prefer 'a better taste' free-living picked snails to commercially farmed snails (4,6).

However, snail collection locations include snail droppings, litter materials, decaying food materials, contaminated water, and decaying animal remains that favour the growth of microorganisms (10). Significant microbial pathogens have been isolated from edible portions of African land snails (Table 4). Akpomie (2013) detected $2.0x10^3$-$2.8x10^4$ cfu/ml of *Escherichia* spp., *Salmonella* spp., *Pseudomonas* spp., *Shigella* spp. and *Bacillus* spp. in African land snails' visceral mass and effluents (10). Nyoagbe et al. (2016) isolated 2.91±3.19-7.39±0.45 cfu/g of Sal*monella spp.,* 7.68±1.40-2.66±2.99 cfu/g of *Staphylococcus* spp., 4.90±1.07-1.53±1.68 cfu/g of *Bacillus* spp. and 5.66±0.14-3.97±0.74 cfu/g of *Pseudomonas* spp. (4).

3.2. Snail vending, handling and preparation

Snail vending, handling and preparation are mainly practiced by rural women who seek to provide financial support and/or nutritious food to their families (38). Here, freshly collected African land snails are often put in old sacks or buckets and transported to homes on the head or in wheelbarrows. To maintain snail humidity, live snails are then stored underneath tree trunks till preparation or subsequent transportation to local markets (2). Live and unpackaged snails are usually sold to consumers, street vendors or retailers in local markets. Barimah (2013) mentioned live African land snails were sold in open sacks and wooden cartons in nine markets (precisely in Greater Accra, Eastern, Volta and Ashanti) in Ghana

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(39). Snails are mobile and can be seen moving about in open vending materials, bench-tops and on the soil (4,39). Vendors strive to restrict live snails from escaping, and it is common for vendors to pick fallen snails on untidy soils, floors, untreated domestic wastes and add to the lots displayed for sale (38,39). In a qualitative based survey conducted in Greater Accra, Ghana, Nyoagbe et al. (2016) reported participants bought unpackaged and unhygienic snails in local markets (4). Consumers revealed pit latrines as one of vendors' snail collection locations in Buea, Cameroon (38). In addition, while describing snail vending activities, Barimah (2013) further mentioned all snail vendors sold in relatively 'dirty' environments (39). "Dirty referred to the proximity of snail vendors to heaped rubbish…flies and muddy water" (p.47).

When purchased, consumers or street vendors transport live snails to their respective homes where snails are deshelled to obtain snail meat. To reduce its slimy liquid, snail meat is mixed with limestone or lime and/or salt for a couple of minutes and rinsed severally with water (2). Snail meat is boiled for about twenty minutes, and then rinsed twice with cold water. The dressing of snail meat includes ingredients such as oil, tomatoes, chili pepper, salt, seasoning cubes, garlic, ginger, onions and herbs (2).

Previous research has microbiologically assessed the local vending, handling and preparation of African land snails. Akpomie et al. (2019) microbiologically analysed dressed snails sold in Abraka main market, Nigeria using four cooking methods (boiling, frying, smoke-drying and oven-drying). Important bacteria isolated included *Bacillus spp., E. coli, Proteus* spp., *Vibro* spp., *Salmonella* spp., *Staphylococcus* spp., *Pseudomonas* spp., *Shigella* spp., *Klebsiella* spp., *Streptococcus* spp. and *Citrobacter* spp. (11). In addition, Oranusi and Nubi (2016) revealed that ready-to-eat snail meat sold at travelers' stop-over terminals along the Lagos-Shagamu expressway, Nigeria contained species of *Bacillus* (31%), *Staphylococcus aureus* (18%), *Klebsiella* (13%), *Escherichia coli* (6%), and *Salmonellae* (2%) (40). These findings indicate food safety risks in the routines of snail meat vendors and consumers, which might be detrimental following significant exposures to microbial pathogens.

3.3. Snail meat preservation

When African land snails are collected from free-living environments, they are mainly sold alive in local markets. However, given they might not be stored in favourable growth conditions, snail death and spoilage may set in within 48 h (41,42). As such, edible snails are also marketed as washed, stewed or smoked-dried. Several temperature-dependent drying methods (such as, oven and sun drying) have been employed to preserve and extend the shelf life of snail meat (41,42). In typical sun drying for example, rural women attach washed snail meat in long sticks (about 1m in length), and expose to sunlight for about 4 to 5 days (42). Attached snail meat is then placed over mild heat. The sticks containing dried snail meat are put in wooden boxes or sacks until consumption or during transportation to local markets. At local markets and during sales, dried snail meat is unpackaged and displayed on open trays for sales (4,42). Subsequently, at the end of each day usually retains unsold snail meat as leftovers which are packed into previous wooden boxes or sacks and transported back home (42,43). These preservation and vending procedures not only

reduce the sensorial and nutritional properties of snail meat but also, expose the meat to environmental and microbiological agents (41-43).

The microbial safety of locally smoked snail meat is under-researched. Tettey et al. (1997) identified unhygienic practices, poor handling, and the sale of unpackaged dried snail meat as microbial contamination sources in Ghana (43). Adeyeye et al. (2020) detected *E. coli, Salmonella paratyphi, Listeria monocytogenes, and Campylobacter jejuni* in cured (treated with 3% salt) smoked snail meat sold in Nigeria (44). The presence of these microbial pathogens in ready-to-eat snail meat has been attributed to poor hygiene during processing (43,44).

4. Snail meat consumption in Africa: a public health perspective

African land snails contain the required nutrients for a balanced diet but may become devastating when invaded by pathogenic microorganisms, thereby leading to foodborne diseases. The symptoms of foodborne infections depend on the health status of the individual and vary from mild (diarrheal, vomiting, dizziness, abdominal pains) to severe and sometimes deathly. In this paper, Table 3 presented snail-associated microbial pathogens which have been linked to foodborne disease outbreaks in many developed and developing countries. In the United States, for example, a *Listeria* outbreak resulted in three hospitalizations and one death in 2021. This outbreak was linked to fully cooked chicken supplied by Tyson Food Inc (45). In the same year, a *Salmonella* outbreak was recorded in whole red, white, and yellow onions imported from Chihuahua state-Mexico, and *E. coli* outbreaks occurred in unknown food sources leading to eleven hospitalisations and one death (45). These bacteria live in the intestines of many farmed animals and infections usually occur when people consume raw or undercooked foods.

Despite the presence of these microbial pathogens in widely consumed African land snails, no links have been made till-date, between human foodborne disease incidence and snail meat consumption. Tanyitiku et al. (2022) reported consumers' apparent unawareness of possible health risks in snail meat consumption practices in Buea, Cameroon (38). Okafor-Elenwo and Imade (2019) estimated that 1750 per 10,000 potential snail meat consumers above the age of 3 years are most likely to fall ill after consuming edible terrestrial snails (*A. marginata*) sold in Nigerian Markets (46). Indeed, data from the World Health Organisation (WHO) showed that low-income countries in Africa are at the greatest risk of food-related illnesses (47). In 2015, foodborne diseases in African regions were estimated to cause 1200-1300 Disability Adjusted Life Years per 100,000 inhabitants (DALYs - one DALY corresponds to one lost year of healthy life) compared to 35-711 DALYs in other regions across the world (47,48). However, these estimates are subjected to uncertainties due to limitations in research and disease surveillance data in Africa (47). For example, if a laboratory diagnosis is provided, there is often no way of telling if the pathogen detected was acquired from food, water, the environment or another person, and if there is a reporting requirement, the reporting system may not be adequate (49). This study has demonstrated a typical example of one of such foods widely consumed in Africa that lack foodborne disease evidence data. It

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revealed that African land snails inhabit significant disease-causing pathogens that could easily be transmitted to snail meat handlers and consumers in their day-to-day snail activities. Therefore, this research prepared a start-up point for fruitful interventions, which will 1) raise awareness on avoidable foodborne outbreaks in local snail meat activities, 2) provide opportunities to improve hygienic standards in local snail consumption practices and 3) serve as a guide to national and international decision makers on food safety issues in African snail meat consumption.

5.Conclusion

Snail meat is a source of food and livelihood for rural people in Africa. However, local consumption practices such as snail gathering, snail meat handling, consumption and preservation could expose snail meat handlers and consumers to significant microbial pathogens. This review revealed that African land snails could be good substitutes for several less affordable animal proteins. It also highlighted potential snail-associated microbial pathogens which could lead to significant health risks during snail handling and consumption. Thus, urgent food safety measures and implementation procedures are required in the consumption of African land snails.

Conflict of interest

The author declares that there is no conflict of interest.

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