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Potential health benefits and risks associated with the consumption of the giant African land snail: a review

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ABSTRACT

The Giant African Land Snail (GALS), which is the biggest known land snail in the world, has been a delicacy in West and Central Africa for several centuries. This study used literature to assess the proximate composition, nutritional and health benefits, and potential health hazard connected with the consumption of the three most common GALS species; *Archachatina marginata, Achatina fulica* (recently renamed as *Lissachatina fulica*) and *Achatina achatina*. The study found that the meat from the snail is highly nutritious on account of the high protein, mineral and vitamin content but low fats and cholesterol. Meat and other products from the snail are used in traditional African folklore medicine for the management of some disease situations such as anaemia, obesity, diabetes, hypertension, and arthritis among others. In addition, by-products from the snail such as shell have potential application as calcium supplements, while the mucus has antimicrobial properties and has been used in cosmetics and for reconstructive surgery. But the consumption of the snail is challenged by the presence of pathogens and parasites, which can potentially cause food-borne diseases and other health problems, which occur mostly among people who consume raw or improperly cooked snail meat. We conclude that the risk of snail meat consumption can be substantially minimized through pre-processing of cultured snails followed by adequate cooking.

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1. Introduction

The Giant African Land Snail (GALS), which is the biggest known land snails in the world, comprise of 13 genera with over 200 species of molluscs, of which the Three commonest species are *Archachatina marginata, Achatina fulica* (recently renamed as *Lissachatina fulica*) and *Achatina achatina* (1). In their native range in Africa, GALS are considered as a delicacy. In many urban centres in West Africa, particularly Nigeria and Ghana, GALS have attained the status of a highly priced delicacy within the reach of mostly the rich people (2).

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GALS are the most commonly consumed land snails in Africa (3, 4).

It is an important source of protein especially for people located along the forest belt of West and Central Africa (5). They are frequently displayed for sale in open markets and along major highways in West Africa (1,4). They provide employment and means of livelihood especially for rural women (6), who typically pick the snails from the forest and sell them in open market or along the highways (1). African diasporas sometimes carry GALS across countries for the purpose of consumption (1). Snail meat is considered chewy and tender, highly nutritive, with a characteristic mushroom-like flavour (7). It is widely accepted as important source of protein in many countries in West and Central Africa especially because of the high mineral and protein content, rich in essential amino acids and low in fats and cholesterol (8). Meat and other products from the snail have been used in traditional African medicine for the treatment of several chronic health conditions including anaemia, diabetes, arthritis (4). The shell and mucus of the snail have been demonstrated to have antimicrobial properties and have been used for wound healing, bone treatment and cosmetics (1). But the snail is currently restricted or banned in most countries outside Africa (1).

GALS originated from Africa, with *A. fulica* originating from the East African coast, while *A. achatina* and *A. marginata* originated from the West African coast. Either based on the perceived importance of the snail then or out of curiosity, in 1800, pair samples of *A. fulica* was intentionally taken from East Africa and first introduced in some Indian Island nations including Mauritius, from where they were introduced into Kolkata in India in 1845. They were initially bred in India, from where they spread further into other Asian countries. In 1936, the snails were introduced into Hawaii, USA from Japan and/or Taiwan (1, 9). It was first reported in the Caribbean Island of Guadalupe in 1984 (10). In 1980s, they were introduced into Brazil from Indonesia and actively promoted for escargot farming. But when the business collapsed, people disposed live snails into various places such as rivers, roadsides, forests, dumpsites etc. from where they spread into the wild in Brazil and into other south American countries (9). Though, some tribes in Brazil consume the snail (11), but they seemed to have evolved into a formidable pest causing problems to biodiversity, small scale agriculture and posing urban nuisance due to the littering of their path with faeces and mucus, and public health challenge due to their harbouring of pathogens and parasites. Not just in Brazil, these problems also occurred in other continents and countries where the snail has been introduced into including Asia, Australia, north and south America. Hence, the ban on the snail in these countries (1).

Recent archaeological evidence based on excavations at Border Cave, Kwazulu-Natal, South Africa showed that ancient Africans roasted and consumed Achatinid snail since 170,000–70,000 years ago (12). Africans have a long history of the consumption of snails, which has remained till date. Currently, in Ivory Coast, nearly eight million kg of Achatinid snail meat is consumed yearly, while domestic demand in Nigeria, Cameroon, and Ghana exceeds supply (13). Processed *A. fulica* is currently sold as food in some Asian countries especially Taiwan, China, and Seoul Korea (7). Other species of land snails are delicacies in other continents

such as *Helix* species and *Cornu aspersum* in Europe (7, 14). However, the consumption of GALS is challenged due to the presence of parasites and pathogens of public health importance (13). Notwithstanding, authors have considered snail meat to be safe for human consumption especially if well processed, prepared and cooked (15). Hence, the aim of this review is to evaluate the proximate composition of GALS meat, highlight their potential nutritional and health benefits, assess the public health risk associated with their consumption and present a safe method of processing and cooking their meat to make it fit for human consumption.

2. Proximate composition of snail meat

Table 1 presents the proximate composition of snail meat as obtained from literature. The moisture content of fresh snail meat is relatively high ranging from 66 – 84%. The level of other parameters is dependent on whether the analysis was done on wet or dry samples. The protein content of snail meat ranged from 10-33% for wet weight and 62-85% for dry weight. Carbohydrate ranged from 0 - 6.13% in the wet snails and 2.25- 27.29% in the dried snails. Crude fat, ash and fibre were generally low in concentration. These three snail species have slight differences in their proximate composition. Though, majority of land snail consumers can't tell the difference among these species. But the few people that know, prefer *A. achatina* followed by *A. marginata* (15).

Numerous researches have shown that snail meat is highly nutritive especially on the account of the high protein and mineral content, low fats and cholesterol (4-20). The protein content of wet Achatinid snail meat of 10–33% is higher than major conventional protein sources including chicken (18.3%), fish (18.0%), cattle (17.5%), mutton (16.4%), and swine (14.5%) (7). the protein of Achatinid snail contains essential amino acids including isoleucine, leucine, lysine, arginine, and phenylalanine (5), but low in methionine (20). Gupta and Khanal (21) reported eighteen amino acids including nine essential and nine non-essential from the meat of the snail. Snail meat also contains vitamin particularly Vitamin C and B complex (22). Snail meat contain several minerals particularly calcium, and others including potassium, zinc, magnesium, phosphorus, copper, manganese and iron but low in Sodium (4, 5, 22). Adegoke et al (17) carried out proximate and mineral content analysis of three different species of land snails and discovered that *A. fulica* was nutritionally richer than *Limcolaria* sp. and *Helix pomatia*. Gupta and Khanal (21) reported Achatinid snails as potential sources of food and feed.

3. Health benefits

Consumers can benefit from the proximate composition of the snail. Nkansah et al. (4) reported that the consumption of GALS meat can enhance good health, with *A. marginata* exhibiting the best nutraceutical value. The different body parts of GALS including *A. fulica* has been used in traditional and folklore medicine in many countries in Africa for centuries. Though, many of the acclaimed uses have not been scientifically validated, but some recent studies tend to lend credence to the scientific veracity of some of the uses. The ban of these species outside Africa has slowed down progress on the pharmacological aspects of the snail.

Table 1. Proximate composition of wet and dry snail meat

Snail species	Prep	Crude protein, %	Crude fat, %	Crude fibre, %	Ash, %	Moisture, %	Carbohydrate, %	Dry matter, %	Reference
Achatina fulica	Wet	10.08	1.61	. ND	1.78	79.28	7.25	ND	(16)
	Wet	19.49	4.63	0.42	2.98	73.37	6.00	ND	(8)
	Dry	62.56	2.27	0.03	3.00	4.88	27.29	ND	(4)
	Dry	72.64	1.48	0.00	4.78	ND	ND	90.29	(17)
Achatina achatina	Wet	19.27	1.43	ND	1.34	77.54	0.42	ND	(18)
	Wet	15.63	2.20	0.14	4.08	84.44	ND	ND	(19)
	Wet	17.20	2.21		2.33	75.28	2.98	ND	(16)
	Wet	20.03	3.85	0.63	3.47	73.72	4.42	ND	(8)
	Dry	71.66	5.06	1.21	3.49	6.1	13.69	ND	(4)
	Dry	82.96	3.98		3.22	6.58	3.26	ND	(5)
Achatina marginata	Wet	12.85	2.57	0.25	7.41	73.14	ND	ND	(19)
	Wet	19.53	2.44		2.56	73.67	1.80	ND	(16)
	Wet	18.83	4.40	0.36	2.90	73.65	6.13	ND	(8)
	Wet	26.12	0.91		3.18	66.27	2.63	ND	(15)
	Wet	20.56	1.38	ND	1.44	76.56	0.007	ND	(18)
	Dry	85.12	4.37	1.32	3.06	5.2	2.25	ND	(4)

ND= Not Detected

Meat and other products from Achatinid snail have many beneficial applications in child and maternal health, in support of Sustainable development goal (SGD 3). For instance, malnutrition is associated with the about half of the 10.7 million deaths of children under five years old in Africa yearly. Hence, snail meat because of their relatively high protein, mineral and vitamin content has been recommended for children in Africa in order to overcome malnutrition (7). In addition, powdered snail meat has been incorporated in the diet of breastmilk-weaned toddlers as alternative food formula (7). The importance of snail meat in maternal health especially during delivery and postnatal has been reported. Engmann et al (5) reported that the eating of snail meat can promote child delivery and enhance the nourishment of lactating mothers. Ademolu et al. (23) opined that the eating of snail meat reduces labour pain during delivery. Among the Igbo tribe of south-eastern Nigeria, Achatinid snail meat is a vital item in the nutrition of nursing mothers (2).

The fat contents of snail 0.96-3.0% is quite low, which is lower than the fat content of conventional protein sources including eggs (21.4%), poultry (9.6%), and mutton (23.0%). Their lipid, which mostly consists of over 50% polyunsaturated fatty acids that is dominated by eicosadienoic and linoleic are considered as healthy. Hence, it is thought that these lipids can play major protective roles in several chronic conditions such as diabetes and obesity, inflammatory and cardiovascular diseases, rheumatoid arthritis lupus, Crohn's disease, cystic fibrosis, and psoriasis (7).

Various body parts of the snail particularly the meat, mucus and shell have been used for diverse purposes especially for the management of several ailments. For instance, because of the high protein and mineral contents and the low fats and cholesterol of snail meat, it was suspected that the meat could promote good health, hence has been used for the treatment of nutritional insufficiencies and manage some chronic diseases such as hypertension, diabetes mellitus, asthma, and stroke (5, 15, 23). Babalola and Akinsoyinu (16) mentioned that the good quality of snail meat makes it useful for the treatment of cardiovascular diseases such as cardiac arrest, hypertension, heart attack, and stroke. Tanyitiku (7) opined that the regular consumption of land snail meat could boost the immune system, hence potentially preventing some chronic health circumstances such as obesity, cardiovascular diseases, type 2 diabetes and some forms of cancers. Tella (24) demonstrated antihypertensive effect of the body tissue extract and visceral fluid of *A. fulica*, and suspected that GALS could contain eledoisin, which is a strong antihypertensive agent found in aquatic snails.

People can also benefit from the mineral content of the snail. For instance, the edible portion of Achatinid snails consists of about 30% minerals (7). Achatinid snail meat contains several minerals especially calcium, iron, zinc, cobalt, copper, manganese, magnesium, phosphorus, and iodine, which performs several functions in the body (7). The most abundant mineral in snail meat is calcium, which occur in the range of 650-700 mg/100 g. Babalola and Akinsoyinu (16) analysed the calcium content of Achatinid snail and reported 126.40 mg/100 g for *A. marginata*, 106.30 mg/100 g for *A. achatina* and 66.30 mg/100 g for *A. fulica*, which they considered to be higher than 7 mg/100 g of beef, 54 mg/100 g for eggs and 120 mg/100

g for milk. Calcium is particularly higher in the shell of the snail than the meat. For instance, Nkansah et al (2021) (4) reported calcium concentration of 656.9 ± 5.46 mg/100 g, 402.29 _± 5.18 mg/100 g and 701.79 ± 4.32 mg/100 g, in the meat, whereas in the shell it was 14,188.53 ± 607.3 mg/100 g, 14,375 ± 288.89 mg/100 g and 13,716.09 ± 99.56 mg/100 g for *A. achatina, A. fulica* and *A. marginata* respectively. Hence, Achatinid snail is a veritable source of bio-calcium, which can be developed as calcium supplements. The health benefits of calcium include calcification of bones and teeth, blood clotting, and functioning of muscles and nerves (7, 16). The iron content of Achatinid snail is quite high. Tanyitiku (7) reported values of 55-56 g/100 g, 41.11g/100 g and 40.00g/100 g while Babalola and Akinsoyinu (16) recorded 1.30 mg/100 g, 1.88 mg/100 g, and 2.29 mg/100 g for *A. fulica, A achatina* and *A. marginata* respectively, which is comparable to iron contents in traditional protein sources such as eggs (1.6 - 2.1 mg/100 g), beef (1.9 mg/100 g), duck (1.08 mg/100 g) and mutton (2.0 mg/100 g). Dietary iron plays several roles in the body such as enhancement of the metabolism of lipids, carbohydrates and protein and can benefit health especially in the treatment of anaemia. Akpomie et al (22) reported a high iron content of Achatinid snail meat i.e., 45-59 mg/kg iron, which could make snail meat useful for the prevention and treatment of anaemia. Other authors have mentioned the use of snail meat for the treatment of anaemia (5, 17).

It has been demonstrated that various snail parts exhibit antimicrobial activities especially the shell powders (25) and mucus (26). Nugrahananto et al (27) identified two proteins, Achasin and mytimacin from the mucus of *A. fulica*, which demonstrated antimicrobial activities against *Aggregatibacter actinomycetemcomitans* and *Streptococcus mutans*. Okeniyi et al (28) demonstrated the antimicrobial activities of the mucus from the three GALS species against both gram positive and gram negative bacteria. Hence, they have been used for the treatment of wounds (29), whooping cough (5, 30) and skin infections (7). Rashad et al. (31) compiled the potential application of the snail mucus including antimicrobial, wound healing, anticancer, cosmetics and anti-ageing, anti-inflammatory and antioxidant. Okoh et al. (32) used Wistar rat to demonstrate the wound healing potentials of the shell of *A. fulica*. The visceral fluid of the snail is used to halt bleeding, wound treatment and healing of amputated limbs (1, 7) and treatment of other diseases such as hypertension, anaemia ulcer, asthma, tuberculosis, and kidney diseases (30).

4. Health risks

One major obstacle to snail consumption, is their harbouring of parasites and pathogens. Ecologically, land snail feed on detritus and vegetation, but harbours different life stages of parasites. Also, snails that veered into peri-urban areas by virtue of their foraging lifestyle consuming waste and filth, tend to harbours pathogens, which present a considerable health risk when consumed. Even cultured snail and the soils around Achatinid snail farms, have been shown to harbour several enteric microbes including coliforms, *E. coli, Vibrio Streptococcus, Proteus, Pseudomonas, Klebsiella,* etc (33). Hence, the challenge of snail farmers especially in Africa, is how to develop snail breeds devoid of parasites and pathogens. This phenomenon is not limited to GALS alone, but also other species of

snails. Parlapani et al. (14) observed the presence of microbes including *Escherichia coli* and *Enterococcus* in the meat and intestines of wild snail species in Greece including *Cornu aspersum* and *Helix lucorum* but observed tremendously lower populations in cultured snails, but *Salmonella* spp. was noticed in the wild snails only. The presence of pathogens in snail meat in Greece and other European countries, did not deter snail farming in these countries, rather, there has been an increasing interest in snails in these countries (14). Hence, snail farming can provide ample opportunity to produce good quality snails devoid of human pathogens suitable for human consumption (34).

Tanyitiku (7) opined that through the scavenging lifestyle of the snail could make the snail ingest or retain foodborne pathogens in their bodies quite easily, which can be potentially spread to humans especially during handling and/or consumption, which could potentially cause food-related disease. Agbonlahor et al. (35) detected *Yersinia enterocolitica, Y. intermedia* and other pathogens such as *Pseudomonas aeruginosa*, *Enterococcus faecalis, Aeromonas hydrophilia, Salmonellas typhimurium, Plesiomonas* shigelloides from improperly processed snail meat. Other authors have also raised public health concerns resulting from the consumption of fresh or uncooked, or improperly processed snail meat (17, 36, 37). For instance, Agbonlahor et al. (35) reported the case of acute gastroenteritis in a 64-year-old man who ate improperly processed *A. marginata* in Nigeria. Laboratory analysis of the snail remnants revealed the presence of *Aeromonas hydrophila* at a high population of 1 x 10^9 cfu/g. It is therefore essential to properly process and cook snail meat in order to eradicate foodborne pathogens (38).

A. fulica is a is a vector or intermediate host of many nematodes including *Angiostrongylus cantonensis* and *Angiostrongylus malaysiensis* which causes eosinophilic meningoencephalitis (rat lungworm), and *Angiostrongylus costaricensis*, which causes abdominal angiostrongylosis in humans (9, 39, 40). Achatinid snails are also potential transitional hosts for some parasites of domesticated and wild animals including *Rhabditis* in cattle, *Oslerus ostratus* and *Aelurostrongylus* in cats, *Strongyluris* in lizards (39) and *Aelurostrongylus abstrusus*, which causes pneumonia among the cat family (40). Using a systematic review, Silva et al. (40) reported 11 species of nematode were associated with *A. fulica* in 21 countries during the period from 1965 to 2021. The rat lung disease is a zoonotic infection that occurs from Southern USA to South America, from Brazil to Argentina (9) and the Caribbean (41). Results of molecular studies show that *An. cantonensis* in Guadeloupe (Caribbean), Hawaii (USA), Brazil and Japan shared a common source (41). These are places where *A. fulica* had been detected as well. Thiengo et al. (9) attributed health risk associated with *A. fulica* for the transmission of *An. costaricensis* especially in urban areas in Brazil to be due to the absence of intermediate host specificity of the parasite, the large population of the snail potentially existing as vectors and the large probability of interaction with persons, which could subsequently lead to transmission to humans. The first instances of human neuroangiostrongyliasis in the Caribbean were detected in Martinique in 2002, Guadeloupe in 2013 and French Guiana in 2017 (41). However, in Brazil, human cases of eosinophilic meningitis occurred mostly among persons who consumed uncooked *A. fulica* (9). There has not be a

single human case of the disease in Florida since 2021 (42), perhaps, this might be due to the eradication of the snail in this place. But in West Africa, where studies have shown the presence of rat lung worm in GALS (43), human cases of the disease are not reported. However, rat lung worm is not restricted to *A. fulica*, but has also been spotted in other snail species in Florida such as *Zachrysia provisoria* and *Bradybaena similaris* (42).

5. Processing snails for consumption

The consumption of edible snails including GALS, is constrained by the presence of normal flora, pathogens and parasites. Like other animals, snails generally harbour microbes in different parts of their bodies particularly the intestines, which can deteriorate the meat or cause disease especially if not properly processed, stored or cooked (22). Toxicological assessment of GALS including their mucus shows that they are not toxic (44). Africans have a long history and tradition of consumption of Achatinid snails from time immemorial. Research has shown that microbial infection from the consumption of Achatinid snails is mostly a result of consuming raw snails, or improperly processed or cooked snail meat or poor handling, which can also occur with other domesticated or wild animal species. Notwithstanding the problems of microbial contamination, *Helix* species continue to be a delicacy in several European cookeries (7). In fact, escargot farming is increasing in Europe especially as an alternative means of obtaining animal proteins (45). However, there are specific ways of processing and cooking snail meat that will be safe for consumption (11).

About 42% of the live weight of molluscs is generally edible (20), which comprises mostly of the foot in Achatinid snails (7). Adeyeye et al. (46) reported that Achatinid snails comprise 36.97 - 45.14% carcass which is edible, while the wastes comprise of 17.12 - 31.99% shell and 18.80 - 22.74% intestines. The snail offal, which consisted of the heart, kidney, intestines and reproductive organs is seldom consumed. Ademolu et al. (47) presented the nutritional value of the visceral, because few people consume it. Studies have shown that microbial contamination is highest in the intestines, visceral mass and foot/head (35). Parlapani et al. (14) working on other snail species including *Cornu aspersum* and *Helix lucorum* found that cultured snails had less microbial contaminants when compared to wild species, *Salmonella* spp. were noticed only in the wild snails, snail meat had lower microbial load than the intestines, and demonstrated significant reduction in microbial loads following appropriate processing and cooking. Snail meat should never be eaten raw or partially cooked.

Application of heat during cooking of snail meat is capable of destroying microbial contaminants (15). Akpomie et al. (22) investigated the result of diverse cooking procedures on the inactivation of contaminating microbes including boiling, frying, smoke-drying and oven-drying. They found that microbes responded differently to the different cooking treatments. They found that all the cooking treatments reduced microbial population significantly while maintaining the nutritional composition and prolonging the shelf-life of the meat. Smoke-drying followed by oven drying had the best results on account of their lowest residual microbial counts.

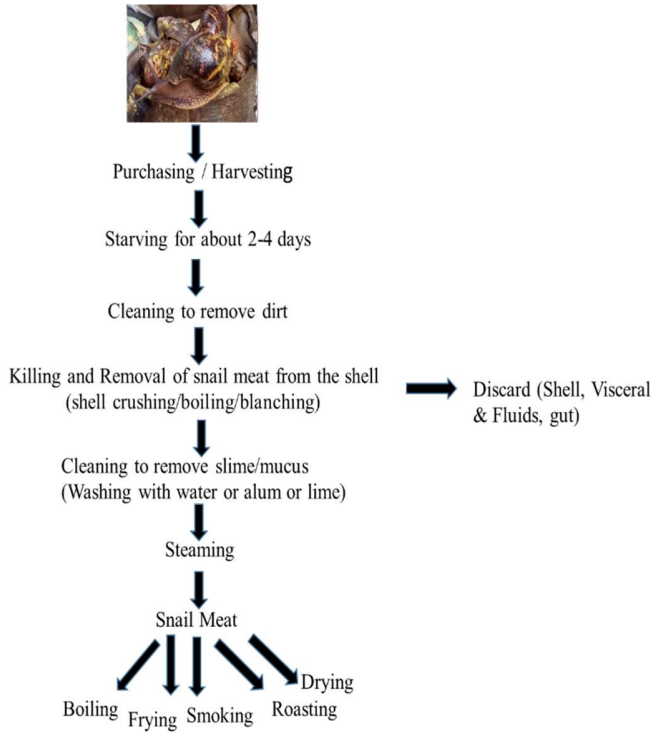

Figure 1. Processing and cooking of Achatinid snail meat suitable for human consumption

Notwithstanding, microbes possessing spores, due to heat resistance, might require more than one cooking phase or treatment. Based on various studies and extensive experience in Africa, a suggested scheme for the processing/preparation and cooking of snail meat safe for human consumption is presented in Figure 1. When the snails are caught from the wild or bought from the open market, they are surface-cleaned properly. They are starved for two days, surface cleaned, killed, separation of the meat from the shell, removal of visceral mass and fluid. The snail meat is then cleaned to remove mucus using alum before initial steaming or irradiation. The steamed meat can therefore be optionally spiced or salted and subjected to any of the following cooking methods; frying, toasting, boiling, smoking or oven drying. Beyond food consumption, recent research attention focuses on the use of bioactive substances from GALS in cosmetic, pharmaceutical and medical sectors (48).

6. Conclusion

Achatinid snails have been consumed in Africa for millennia without documented adverse health effects. Consumers of the snail benefit from the proximate composition of the meat. Snail meat is regarded as nutritious and healthy on account of its high protein, vitamin and mineral content especially calcium and iron but low in lipids including saturated fats and cholesterol. Snail meat is used as an alternative source of animal protein, which is useful to combat protein malnutrition. Snail meat is also used in traditional medicine for the treatment of diverse chronic disease conditions including anaemia, diabetes, obesity, hypertension and arthritis. But consumption of snail meat presents a public health risk as a result of the normal flora, pathogens and parasites which they harbour. Notwithstanding, snail meat meant for human consumption should be prepared adequately through pre-treatment followed by adequate cooking, which can potentially eliminate or significantly reduce their microbial load to an acceptable level safe for human consumption.

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Authorship contribution

EIO conceived the study, carried out Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, and Writing – original draft, while IYO and EEC carried

out Writing – review and editing. All authors approved the final submission.

Declaration of competing interest

All authors declared no competing interest in carrying out the work

Data availability

This publication contains the data generated from the review.

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