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Research Article

Nutrient Analysis of Edible Land Snails (Achatina achatina) in the Enugu State, Nigeria

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Abstract:

Background: Snail meat is a great source of protein and various mineral elements. Although snails are consumed as food in many Nigerian communities, they are underutilized in efforts to prevent malnutrition. The aim of this study was to determine the proximate composition and mineral analysis of edible land snails (Achatina achatina) sold in the Enugu State, Nigeria.

Methodology: Snails were purchased from markets in the Enugu State. They were killed by striking the shells carefully with an iron rod and the foot (the edible portion) was separated from the offal. The resulting fresh meat was dried to constant weight using a hot air oven to determine the moisture content. Proximate and mineral analyses were carried out on the resulting dry snail meat. Crude protein, fat, fiber, and ash contents were determined using the standard methods of the Association of the Official Analytical Chemists. Carbohydrate content was determined by difference. Phosphorus content was determined using the molybdenum blue method, calcium and magnesium contents were determined using the complexometric titration with EDTA method. Sodium and potassium contents were determined using the Flame Photometry method.

Results: The fresh snail meat contained 71.65±1.51% moisture. Proximate analysis of the dry matter revealed the contents as follows: ash (2.80±0.19%), protein (14.46±0.63%), fiber (4.15±0.21%), fat (0.05± 0.02%), and carbohydrate (6.39±0.18%). Mineral analysis showed that dried snail meat contained: phosphorus (3.8±0.26 mg/100g), calcium (118.30±1.74 mg/100g), sodium (0.34±0.03 mg/100g), potassium (13.50±0.58 mg/100g), and magnesium (98.60±1.30 ppm),

Conclusion: The results of this study revealed that Achatina achatina is rich in protein and minerals, but low in fat, and that its consumption may help in alleviating human malnutrition.

Key words: Africa; land snails; minerals; nutrition; proximate analysis

Introduction

Edible land snails are classified under the Regulation of the European Community (EC) No. 853/2004 as terrestrial gastropods belonging to the species Helix pomatia Linné, Helix aspersa Muller, Helix lucorum, and those in the Achatinidae family (1). These snails possess a specialized respiratory organ known as the "pallial lung" or "lung cavity," which enables them to extract oxygen from the air and undergo pulmonate or air-breathing respiration (2). A mature African land snail is dark brown in color with dark stripes and streaks or reddish-brown color with pale yellow vertical markings (Figure 1). One snail may weigh up to 600 g and varies between 3 -25 cm in length (3).

Figure 1: Achatina achatina: A giant African land snail in its natural habitat.

Snail droppings, litter materials, decaying food materials, contaminated water and decaying animal remains that favor the growth of microorganisms are places from which edible snails can be collected (4). Snail collecting varies according to the gathering locations (bushes, forests, farmlands, and footpaths) – as well as with weather conditions, especially after heavy downpours at night (3,5,6). Rural inhabitants use torch lights to search for snails in backyards, farms and plantations on rainy nights between 9:00 o'clock at night until 5 o'clock in the morning (8). In daytime, Snail collection can be in dark and damp areas such as underneath farm clearing and decaying vegetation (6,7).

Snail meat is a source of food and livelihood for many inhabitants of West Africa, especially in the rural areas (8). Due to the high cost of conventional meat (beef, pork, chicken…etc.) and various limitations in food crop production, snail meat has become a source of protein and other mineral constituents for many families in rural and urban areas in Nigeria and several African countries (3,5,7,9). Snail meat is tender and have a peculiar favorable mushroom flavor (10). It is a nutritious food which is high in protein, Iron, Calcium and Phosphorous, but contains low proportions of sodium (11). Also, snail meat is rich in essential fatty acids such as linoleic and linolenic acids which have health benefits (11). Children, pregnant women and old persons need snail meat, which is recommended as a good replacement for other animal protein as a way of mitigating the adverse effects of protein-energy malnutrition (8). The use of powdered snail meat enriched food in the feeding of weaned babies in place of breast milk is highly encouraged (12).

One of the most devastating problems facing developing countries is inadequate nutrition or malnutrition (8). According to the World Health Organization of the United Nations, malnutrition registers about 49% out of 10.7 million deaths in Children under the age of five every year (13). Unfortunately, the use of snails to combat malnutrition has been given relatively poor attention in the agricultural sector, despite the fact that a variety of snail species are commonly eaten by members of many communities around the world. Edible snails usually sold in markets are handpicked from the forest or their natural habitats and they are considered as being wild (7). According to Baghele et al. (2022), 15% of snails used as food come from snail breeding while the remaining 85% are gotten from their natural habitats. Snail farming, also known as heliculture, is not new to the agricultural sector, but attempts to fully tap into this food resource have been minimal, leaving it largely underutilized (14).

The aim of this study was to determine the proximate/nutrient and mineral analysis of edible snails to reveal their nutritive value and to what extent they can be a remedy to combat malnutrition.

Materials and Methods

Sample collection

Snails for this study were obtained from the Gariki Market in Enugu Metropolis, Enugu Nigeria. Samples were handpicked by traders from natural surroundings near their homes. These homes can be situated anywhere from 5 to 20 kilometers away from the Gariki market. For example, in Enugu traders living in nearby villages like Agbani or Amechi may travel approximately 10-15 kilometers to reach that market where they sell their snails. A variety of land snail species such as Achatina achatina, Archachatina marginata, and Achatina fulica were available at this geographical location. Achatina achatina was used for this study because it is the most common and most abundant species available at the Gariki market. It is also a preferred choice among consumers due to its large size and a higher meat yield. The purchased snails were killed by striking an iron rod on the shell carefully. The foot (the edible portion) was separated and dried in the oven at 60°C to constant weight. The dried snail meat was ground into fine powder before being used for the nutrient and mineral analyses.

Six samples of Achatina achatina were used for proximate determinations. The standard methods of the Association of Official Analytical Chemists (15) were used to determine the moisture, ash, crude protein, crude fat and crude fiber content of the dried snail. Total carbohydrate content was determined by difference. Crude protein content of 1.0 g sample of dried milled snail was determined using the Micro-Kjedahl method. Crude fat content was determined using the Soxhlet extraction method. Ash content was determined using the Muffle furnace method. The moisture content of 2.0 g sample of dried and milled snail was determined using the oven drying method, while the Acid-Base digestion method was used to determine the fiber content of the snails.

Mineral analysis

5 samples of Achatina achatina were analyzed for phosphorus, calcium, magnesium, sodium and potassium. Phosphorus, calcium, magnesium, sodium and potassium analyses were determined as described by Pearson (16). The phosphorus content was determined using the molybdenum blue method, calcium and magnesium contents were determined using complexometric titration with EDTA method and sodium and potassium content was determined using the Flame Photometry method.

Results

Proximate analysis

The highest content of fresh snail meat was moisture with 71.65±1.51% concentration, and that makes the dry matter account for about 28,5%. Table 1 shows the value of different contents of the dry matter of snail meat. namely: ash, protein, fiber, fat and carbohydrate. Composition of such dry matter was as follows: fat had the lowest value with 0.05±0.02% concentration, crude protein content was 14.46±0.63% - and the contents of carbohydrates, fiber and ash were 6.39±0.18%, 4.15±0.21% and 2.80±0.19% - respectively.

Samples N=6	Ash (%)	Protein (%)	Fiber (%)	Fat (%)	Carbohydrate (%)
Dried meat of *Achatina achatina*	2.80±0.19	14.46±0.63	4.15±0.21	0.05±0.02	6.39±0.18

Values are expressed as averages ± standard deviations.

Table 1: Proximate composition of dried meat of land snails.

Mineral analysis

Table 2 shows the value of five different minerals which includes phosphorous, calcium, magnesium, sodium and potassium. Calcium was the highest value with 118.30±1.74 mg/100 g while sodium was the lowest value with 0.34±0.03 mg/100 g. Magnesium content was 98.60±1.30 mg/100 g while potassium and phosphorous contents were 13.50±0.58 mg/100 g and 3.8±0.26 mg/100 g – respectively.

Sample N=5	P (mg/100 g)	Ca (mg/100 g)	Mg (mg/100 g)	Na (mg/100 g)	K (mg/100 g)
Dried meat of *Achatina achatina*	3.8±0.26	118.30±1.74	98.60±1.30	0.34±0.03	13.50±0.58

Values are expressed as averages ± standard deviations.

Table 2: Mineral composition of dried meat of land snails.

Discussion

The moisture content of the snails was 71.65±1.51%. This value was low when compared to 84.44% and 83.30% reported by Mumeen and Nwandu, 2021 (17) and Offiong et al. 2013 (18) - respectively. Excess water increases the rate of microbial growth. This result suggests that snails sold in the Gariki Market in the Enugu State Metropolis would be less susceptible to microbial contamination and would be safer for consumption.

The results of the proximate analysis of the dry matter of snail meat in this study showed that the crude protein content was highest compared to other components that were analyzed. This is because snail meat primarily consists of muscles, and that proteins are essential components of all living cells (19). The value of crude protein was slightly lower than 15.63% and 17.20% reported by Mumeen and Nwandu, 2021 (17) and Babalola and Akinsoyinu, 2009 (20) - respectively. This implies that snail meat may be used in a powdered form to prepare nutritious food for babies who are weaned from breast milk to prevent protein-energy malnutrition in children under five years old (19).

The crude fiber content of snail meat (4.15±0.21%) was higher than 1.21±0.03% and 0.18% reported by Nkansah et al, 2021. (21) and Akinnusi et al., 2018 (22) respectively. The presence of crude fiber content suggests that consumption of snail meat would be beneficial to the digestive system and in enhancing the production of important intestinal bacteria.

The fat content of the snail meats was 0.05±0.02%. This value was low compared to 3.98±0.11% and 2.20% reported by Engmann et al., 2013 (12) and Mumeen and Nwandu, 2021 (17) - respectively. Low fat diet helps to reduce the risk of heart diseases. The low fat content of snail meat sold in Gariki Market in Enugu Metropolis of Enugu State, suggests it can be used to reduce the risk of obesity and heart diseases.

The carbohydrate content of the snails (6.39±0.18%) was low compared to 13.69±0.15% reported by Nkansah et al., 2021 (21) but high when compared to 3.26±0.13% reported by Engmann et al, 2013 (12). The carbohydrate content was relatively low because snail meat is mainly composed of animal protein and snails are slow in locomotion therefore only a small amount of glycogen needs to be stored (12). Low carbohydrate diets helps to lower triglyceride levels in the blood stream, reduce blood sugar levels and increase high density lipoprotein cholesterol (the good cholesterol) in the body (23).

The ash content of the snail meat (2.80±0.19%) was slightly higher compared to 2.33% reported by Babalola and Akinsoyinu, 2009 (20). The ash content signifies the total mineral content and this result would suggest that snail meat sold in Gariki Market in Enugu State Metropolis is a good source of minerals.

The phosphorous content of the snails (3.8±0.26 mg/100g) was low compared to 145.7 mg/100g and 272 mg/100g reported by Baghele et al. (14) and Eruvbetine, 2012 (24) for snail meat respectively. It has been shown that phosphorous reduces hypophosphatemia (12,25).

The calcium content of the snails was 118.30±1.74 mg/100g. This value was the highest compared to other minerals analyzed. This result agrees with Baghele et al. (14) that calcium is one of the most abundant minerals in edible snails. Calcium is an essential macro mineral which plays an important role in teeth and skeletal development. It also regulates acid-alkaline balance in the body (19).

Magnesium analysis of the snails (98.60±1.30 mg/100g) was high compared to 63.35mg/100g and 69.8mg/100g recorded by Offiong et al., 2013 (18) and Baghele et al., 2022 (14) for snail meat - respectively. Magnesium is an essential mineral for bone formation and diseases prevention, such as cardiovascular disease and Alzheimer's disease (26).

The sodium content of the snails was 0.34±0.03 mg/100g. This value was the lowest when compared to the other minerals analyzed. This is in agreement with the findings of Baghele et al. (14) that edible snails have a low sodium content. Sodium is a macro mineral that is essential in the transmission of nerve impulses and in the absorption of sugars and amino acids from the digestive tract.

The potassium content of the snails (13.50±0.58 mg/100g) was low compared to 114.65±0.44% reported by Nkansah et al. (21). Potassium is necessary as it enhances contractility of smooth, skeletal and cardiac muscles and affects the excitability of nervous tissue (12,25).

Snails are sold in different forms which includes fresh snails, sold in their shells and as smoke-dried snail meat, which are shelled or skewered on a stick (7). Fresh snails are the most preferred because they have a higher nutrient retention, higher moisture content, better texture and flavor and a reduced sodium content when compared to dried snail meat. Snail meat could be eaten by mixing them with other ingredients to prepare meals. Examples includes snail soup, snail stew, grilled snails, fried snails and snail kebabs. When combined with other foods, snails could be used as an alternative source of protein to replace more expensive animal proteins (8). In France, they are prepared as a traditional dish known as "Escargot de Bourgogne" which features butter, garlic and parsley (27). In Nigeria and some parts of Africa, Snail meat, commonly known as "Congo meat" is a delicacy enjoyed by consumers and serves as one of the most primary and affordable sources of protein (20,28,29). Dried snail meat could also be incorporated as an ingredient in packaged food or ready to use meals. Examples includes soup mixes, seasoning blends, canned foods and precooked meals.

Consumption of snails with a high concentration of heavy metals poses a significant risk to human health. According to Onuoha et al. (30), snails of the species Archachatina marginata collected from crude oil producing regions in the Rivers State, Nigeria were not safe for human consumption due to the carcinogenic risk posed by the high amount of nickel in them. There is also a high possibility of snail meat being contaminated with lots of microorganisms because of their natural habitat as well as their feeding habits (7). A study conducted by Nwuzo et al.,, 2016 (31) revealed that edible snails (Achatina achatina) sold as meat in Nwofe, Eke-Aba, Iboko markets in Abakiliki, Nigeria were contained with Escherichia coli, Pseudomonas spp., Shigella spp., Enterobacter spp., Salmonella spp. and Klebsiella spp. Proper sanitation of snail farms, along with careful handling and processing of them, will help prevent these health hazards, making them a desirable food source (25).

Snail meat can play a significant role in alleviating malnutrition and micronutrient deficiencies particularly in rural and low income communities where access to diverse and nutrient-rich food sources is limited. A study conducted by Essien et al., 2016 revealed that snail meat contains essential amino acids (Arginine, Isoleucine, Histidine, Leucine, Methionine, Lysine, Phenylalanine, Tryptophan, Threonine, and Valine) which the body cannot produce on its own. Essential amino acids are required by the body as they play a role in various functions such as tissue development, energy generation, immune response and nutrient absorption (32). Thus, being a good source of animal protein, snail meat can be used to reduce the incidence of protein related deficiencies such as kwashiorkor, marasmus and stunted growth in children (12). Dry snail meat can be ground into powder to prepare nutritious food for weaning babies, especially in forested regions to help prevent protein-energy malnutrition in children under five years old (12). Unlike other sources of animal protein, snail meat is low in fat and cholesterol. The low fat and low cholesterol contents in snail meat makes it a good remedy against vascular diseases such as heart attacks, cardiac arrest, hypertension and stroke (20).

Additionally, snail meat is composed of essential micronutrients such as calcium, iron, magnesium, potassium, manganese, copper, zinc and vitamins A, E, B1, B2, B3 and B6 (33,34). Therefore, consumption of snail meat can help to alleviate these conditions. Vitamins A, E, B1, B2, B3, and B6 play crucial roles in human metabolism and the immune system (34). Calcium is the most abundant mineral in snail meat and it is crucial for proper clotting of blood (12), among other biological (metabolic) functions. The iron content in Achatina fulica (55-56 g/100g), Archachatina marginata (40.00 g/100g) and Achatina achatina (41.11 g/100g) is effective in treating anemic conditions (5,12). Deficiency of magnesium in humans can lead to irregular heartbeat, palpitations and a decreased ability to detoxify (33). Potassium deficiency leads to muscle weakness, fatigue and deterioration of the nervous system and heart (33). A zinc deficiency is characterized by stunted growth, loss of taste and hypogonadism, which can result in reduced fertility (35).

Conclusion

The results obtained from this study showed that edible snail sold in Gariki Market in Enugu Metropolis of Enugu state is high in protein, low in fat and carbohydrate and contains minerals such as phosphorus, calcium, magnesium, sodium and potassium. This suggests that snail meat may be used as a remedy against malnutrition.

Recommendation

The results of this study revealed the presence of nutrients such as protein, fat, crude fiber, ash, carbohydrates and minerals such as phosphorus, calcium, magnesium, sodium and potassium in healthy proportions. It is recommended that snail farming should be promoted, as it will enhance the safety and nutritional value of snail meat, and suggest that snail meat be included in the diets of individuals suffering from malnutrition.

Declaration

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