

In vitro antihelminthic studies on the leaves, stem and root barks of *Cassia alata*



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Background: The use of synthetic antihelminthic agents is often associated with adverse side effects and increasing drug resistance. These challenges have intensified the search for safer and more effective plant-based bioactive agents.

Aim: To evaluate and compare the *in vitro* antihelminthic efficacy of the leaves, stem and root barks of *Cassia alata*.

Setting: This study was designed to validate the folkloric application of *C. alata* as an antihelminthic agent.

Methods: Crude ethanol extracts of the plants' leaves, stem and root barks were prepared and subjected to phytochemical screening. Extract concentrations (25 mg/mL, 50 mg/mL and 100 mg/mL) were tested *in vitro* against *Pheretima posthuma* by measuring paralysis and death times. Mebendazole (MBZ) (15 mg/mL) served as the reference drug.

Results: Phytochemical analysis revealed the presence of tannins, alkaloids, saponins and flavonoids. The root bark showed the lowest activity overall; however, at 50 mg/mL and 100 mg/mL, it produced significantly ($p < 0.05$) shorter paralysis times (23.02 ± 1.61 min and 14.00 ± 2.61 min, respectively) than MBZ (32.00 ± 0.82 min). Only the 100 mg/mL root extract achieved a significantly ($p < 0.05$) shorter death time (57.67 ± 1.71 min) compared to MBZ (110.33 ± 1.70 min). In contrast, the leaf and stem bark extracts outperformed MBZ, producing significantly ($p < 0.05$) shorter paralysis and death times at all tested concentrations.

Conclusion: *Cassia alata* exhibits notable antihelminthic activity.

Contribution: The study highlights *Cassia alata* as a promising plant-based treatment for helminth infections.

Keywords: *Cassia alata*; antihelminthic; *Pheretima posthuma*; paralysis time, death time.

Introduction

Helminth infections affect both animals and a large proportion of humans, predominantly in tropical and subtropical regions, impacting an estimated 1.5 billion people worldwide (Chen et al. 2024; Salim et al. 2023). In developing countries, particularly, these infections pose a significant public health challenge, with children most vulnerable (Riaz et al. 2020). Globally, helminth infestations contribute to physical and cognitive stunting, with 22% of children under 5 years affected in 2020 alone (Raj et al. 2022).

To treat these helminth infections, several synthetic antihelminthic agents are used and are generally effective. However, their use is sometimes associated with undesirable side effects, including abdominal pain, diarrhoea, neuropsychiatric disturbances and urticaria (Broyles et al. 2020; Singh et al. 2025, Sunita et al. 2017). Additionally, the inappropriate and indiscriminate use of these agents has contributed to the development of drug resistance in both humans and animals, leading to treatment failures and a concomitant increase in mortality and morbidity (Fissiha & Kinde 2021; Harshita & Nonika 2024; Lo et al. 2025). In 2018, studies have reported a decline in the efficacy of both albendazole and mebendazole (MBZ) against previously susceptible helminths, with reductions of up to 15% over a 20-year period (1995–2025), largely as a result of their extensive use. In pregnant women, such infections with resistant helminths can be life-threatening, whereas in children, they may result in poor growth, reduced school attendance and long-term impacts on future economic productivity (Pilotte et al. 2022).

To address these challenges, increasing attention is directed towards medicinal plants as potential sources of new bioactive compounds with antihelminthic activity (Latif & Nawaz 2025).

In developing countries such as Ghana, numerous medicinal plants are traditionally used to treat helminth infections; however, rigorous scientific validation of their folkloric use remains limited (Etaware et al. 2025).

Cassia alata (Fabaceae) is a shrub found mostly in West Africa and some other parts of the world. It is commonly used by traditional healers along the west coast of Africa for the treatment of various ailments. Various extracts of its leaves have been reported to possess antihelminthic, analgesic, antibacterial, hypoglycaemic and fungicidal properties, amongst others (Ahmed et al. 2021, Colin et al. 2024; Elshershaby et al. 2025; Saptarini et al. 2024; Sasmita et al. 2024, Tianhoun et al. 2020; Toh et al. 2023). In addition, extracts of the stem and root barks have been reported to exhibit broad-spectrum antibacterial activity (Toh et al. 2023). Thus, the leaves of *C. alata* remain the most commonly utilised part in traditional medicine, underscoring the need to explore the antihelminthic potential of other plant parts, such as the stem and root barks.

Further research conducted on *C. alata* has led to the isolation of several compounds from its various parts, including kaempferol (from the leaves), chrysoeriol-7-*O*-(200-*O*- β -D-mannopyranosyl)- β -D-allopyranoside (from the seeds), emodin and chrysophanol (from the roots), just to mention a few (Fatmawati et al. 2020).

This study aims to evaluate and compare the antihelminthic properties of the leaves, stem and root barks of *C. alata* to provide scientific support for its folkloric use.

Research methods and design

Collection of plants

The leaves, stem bark and root bark of *C. alata* were collected from the wild during the rainy season, when the plants are generally most luxuriant, in May 2018 in the Eastern Region of Ghana (5.92949, -0.93894). The plant materials were identified and authenticated by a curator and botanist at Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. Voucher specimens – CU/PHSC/2018/L021 (leaves), CU/PHSC/2018/S015 (stem bark) and CU/PHSC/2018/R025 (root bark) – were prepared and deposited in the Pharmacognosy Section of the School of Pharmacy, Central University, Ghana.

Preparation of plant materials

The samples were washed with distilled water to remove debris and then air-dried at ambient temperature (25 °C – 28 °C) for 21 days. The dried plant samples were subsequently milled into a coarse powder using a laboratory mill (CT 293 Cyclotec).

Chemicals and drugs

All chemicals and solvents used were of analytical grade. The pure MBZ powder (99.9% w/w) was obtained from Entrance Pharmaceuticals Ltd, Ghana.

Extraction of plant materials

The extraction was carried out following previously described procedures (Adu et al. 2015). A quantity of 500 g of each sample was weighed and extracted with 70% v/v ethanol (Qualikem, India) by cold maceration for 96 h, during which the plant material was exhaustively extracted. Following extraction, the mixtures were filtered using a filter paper with the aid of a vacuum pump. The resulting filtrates were concentrated *in vacuo* using a rotary evaporator (Buchi, Germany, R210) at 40 °C to obtain crude residues. These residues were further dried in an oven at 40 °C to yield solid extracts of constant weight. The dried extracts were then transferred into pre-weighed vials, appropriately labelled and stored at 4 °C until further use.

Determination of extract yields

$$\text{Extract yield } (Y_3) = Y_2 - Y_1$$

where; Y_2 = weight of vial + crude extract

Y_1 = weight of empty vial

Percentage yield (%) = $[(Y_2 - Y_1)/\text{weight of powder used}] \times 100\%$ (Edegbbo et al. 2023)

Thus, the percentage yields for the leaves, stem and root barks were 2.60%, 1.70% and 0.87%, respectively.

Phytochemical screening

The extracts were subjected to phytochemical screening to detect the presence of some secondary plant metabolites such as alkaloids, flavonoids, terpenoids, steroids, saponins, phenol, tannins, carbohydrates, starch, glycosides and coumarins using standard qualitative procedures (Benmehdi et al. 2012; Jaradat et al. 2015, Karande et al. 2016; Madike et al. 2017, Mustapha et al. 2016).

For alkaloid detection, 0.5 g of the extract was dissolved in 10 mL of 0.1 M HCl (Daejung Chemicals and Metals Company Limited, Gyeonggi-do, South Korea) on a steam bath and filtered. To the filtrate, 1 mL of Mayer's reagent (Fisher Scientific, Loughborough, United Kingdom) was added dropwise, and the formation of a yellowish precipitate indicated the presence of alkaloids. For flavonoid detection, 0.5 g of extract was dissolved in 10 mL of water and filtered. The filtrate was treated with 2 mL of 10% NaOH solution (Daejung Chemicals and Metals Company Limited), and the development of an intense yellow colour indicated the presence of flavonoids. For terpenoid detection, 0.5 g of extract was dissolved in 10 mL of chloroform (Fisher Scientific) and evaporated on a steam bath. The resulting residue was boiled with 2 mL of concentrated H_2SO_4 (Daejung Chemicals and Metals Company Limited) and observed for the development of a grey colour. For steroids, 0.5 g of the extract was dissolved in a mixture of 2 mL each of chloroform (Fisher Scientific) and concentrated H_2SO_4 (Daejung Chemicals and Metals Company Limited), and observed for the appearance of a red colour in the lower chloroform layer. For saponin detection, 0.5 g of the extract was dissolved in 10 mL of distilled water and shaken vigorously. The formation of a persistent foam indicated the

presence of saponins. For tannins and phenols, 0.5 g of extract was dissolved in 10 mL of distilled water and filtered. To the filtrate, 2 mL of 3% ferric chloride solution (Gatt-Koller, Absam, Austria) was added, and the formation of a black or blue-green colour indicated the presence of tannins (intense and persistent colouration) and phenols (less intense colouration). For carbohydrate detection, 0.5 g of extract was dissolved in 10 mL of distilled water and filtered. The filtrate was hydrolysed with 5 mL of 0.1 M HCl (Daejung Chemicals and Metals Company Limited), neutralised with 5 mL of 0.1 M NaOH (Daejung Chemicals and Metals Company Limited), and heated with 5 mL of Fehling's A and B solution (Fischer Scientific). The formation of a red precipitate indicated the presence of carbohydrates. For starch detection, 0.5 g of extract was dissolved in 5 mL of distilled water and filtered. To the filtrate, 10 mL of a saturated solution of NaCl (Daejung Chemicals and Metals Company Limited) was added and heated. After heating, starch reagent (an aqueous solution of 1% iodine and 2% potassium iodide) (Fischer Scientific) was added, and observed for the development of a blue-purple colour. For coumarin detection, 0.5 g of the extract was dissolved in 10 mL of distilled water and filtered. To the filtrate, 3 mL of 10% NaOH (Daejung Chemicals and Metals Company Limited) was added and observed for the development of a faint yellow colour. For glycoside detection, 0.5 g of the extract was dissolved in 10 mL of distilled water and filtered. To the filtrate, 2 mL each of acetic acid (Gatt-Koller) and chloroform (Fisher Scientific) were added, followed by a few drops of concentrated H_2SO_4 (Daejung Chemicals and Metals Company Limited). The development of a green colour indicated the presence of glycosides.

Experimental organism

Adult Indian earthworms (*Pheretima posthuma*), measuring 3–6 cm in length and exhibiting anatomical and physiological similarities to human intestinal roundworms, were obtained from a water-logged area in the vicinity of Central University, Accra, Ghana. The worms were washed with normal saline (0.9% w/v) to remove all debris and subsequently preserved in the same solution (Anbu et al. 2015; Sarmah et al. 2024).

In vitro antihelminthic activity evaluation

The experiment was carried out using established procedures with minor modifications, particularly in the extract concentrations and choice of reference standard (Anbu et al. 2015). Test extract concentrations at 25 mg/mL, 50 mg/mL and 100 mg/mL were prepared in distilled water. Mebendazole at a concentration of 15 mg/mL was used as the reference standard, whilst 0.9% w/v normal saline served as the negative control.

Experimental procedure

Twenty millilitres of the various extract concentrations and the reference standard were added to separate Petri dishes, each containing five earthworms. Observations were made

on the times required for the different extract concentrations and MBZ to induce paralysis and death in the individual worms. Paralysis was defined as the absence of movement, except when the worms were vigorously shaken. Death was confirmed when the worms exhibited no motility, even after being pricked with a needle or upon exposure to warm water (50 °C), accompanied by a fading of body colour. Extract concentrations at which the worms retained vigorous motility and life after ≥ 360 min of exposure were classified as having no antihelminthic activity (Klu et al. 2016).

Statistical analysis

The paralysis and death times for each of the five worms were recorded and presented as mean $\pm$ standard deviation ($n = 5$). To determine statistical significance of the paralysis and death times relative to those of MBZ, the reference standard, a two-tailed t test was performed at a 95% confidence interval ($p < 0.05$).

Ethical considerations

All ethical considerations, institutional and international standards for research integrity, have been strictly followed in this study. The research adheres to all relevant ethical guidelines applicable to plant research. No activities involving genetically modified, endangered or protected organisms requiring special ethical approval were conducted. Any potential environmental or conservation concerns were carefully assessed and managed in accordance with established international best practices.

Results and discussion

Extraction of plant material and yields

Medicinal plants remain an invaluable source of therapeutic agents due to their rich composition of bioactive compounds, which often act synergistically and interact with multiple biological targets. Consequently, their effectiveness in the treatment of various ailments, including antihelminthic infections, has been well established. *Cassia alata* has been reported to possess notable antihelminthic activity; however, most existing studies have primarily focused on its leaves (Bih et al. 2025; Elshershaby et al. 2025; Tianhoun et al. 2020). This study therefore evaluated and compared the antihelminthic potential of the leaves, stem and roots.

In investigating the bioactivity of any medicinal plant, the plant material is first subjected to extraction to obtain bioactive constituents necessary for characterisation and further analysis. The use of ethanol as the extraction solvent in cold maceration is justified by local reports indicating its widespread traditional use in preparing plant-based medicines. Commonly used as a mixture with water, 70% ethanol provides optimal polarity, making it very effective in extracting a broad spectrum of phytochemicals in high yields (Ncama et al. 2025; Tourabi et al. 2023). Consequently, preliminary studies on traditionally used plant materials should be conducted using ethanol extracts to obtain reliable results.

The yields of extracts obtained from the leaves, stem and root barks were 2.60%, 1.70% and 0.87%, respectively, indicating a variation in extractable constituents amongst the different plant parts. The higher yield observed in the leaves suggests a greater abundance of extractable compounds, comprising bioactive and non-bioactive components, compared to the stem and root (Nortjie et al. 2022).

Preliminary phytochemical screening

Results from the phytochemical screening revealed the presence of alkaloids, flavonoids, saponins and tannins in the leaves, stem and root barks of *C. alata*. However, terpenoids, steroids, phenols, carbohydrates, starch, coumarins and glycosides were not detected (Table 1).

These findings contrast with literature reports, which, in addition to the detected phytochemicals, also documented the presence of the undetected phytochemicals in the extracts (Angelina et al. 2021; Edegbo et al. 2023). The observed discrepancy may be attributed to factors like the time of harvest, geographical location of the plants, the extraction method used, the age and the method of storage of the harvested plant material as well as agro-ecological conditions, including soil mineral concentration and other specific environmental factors that affect plant growth (Abdisa et al. 2025; Dhiman et al. 2025; Edegbo et al. 2023). It is important to note that such phytochemical variability within the same plant can lead to significant differences in bioactivity (Tlhapu et al. 2024).

In vitro antihelminthic activity evaluation

Extract concentrations of 25 mg/mL, 50 mg/mL and 100 mg/mL from the roots, stem and leaves were evaluated for their antihelminthic activity. Such relatively high extract concentrations, often ranging from 25 mg/mL to 100 mg/mL, are commonly used in preliminary antihelminthic studies using *P. posthuma* as the test organism (Ishnava & Konar 2020; Kancherla et al. 2019; Mathias et al. 2021). The use of such high concentrations was necessary to determine whether any death or paralysis of the test organism would be observed within a short, practical observation period, with a goal to establish an effect first, which could be optimised in further studies. Furthermore, since crude extracts were used, higher doses

were necessary to elicit effects comparable to those of pure, isolated compounds. It is important to note that even higher extract concentrations (100 mg/mL – 200 mg/mL) have been reported in studies conducted elsewhere (Shafi et al. 2021).

Albendazole was used as the reference drug at a concentration of 15 mg/mL, consistent with concentrations employed in similar studies conducted elsewhere (Hossain et al. 2024; Vennila & Nivetha 2015). Since it has poor water solubility, this high concentration ensured that a sufficient amount of the drug was present in solution to interact with the worms, even though most of it remained in suspension rather than in solution (Chai et al. 2021). Additionally, albendazole serves as a benchmark for antihelminthic activity. It is worth noting that a higher concentration of 20 mg/mL has also been employed in *in vitro* antihelminthic studies conducted elsewhere using *P. posthuma* as the test organism (Asiamah et al. 2024; Ishnava & Konar 2020). Moreover, other researchers have described studies in which a commercially available albendazole oral suspension (20 mg/mL) was used as the standard control for comparing antihelminthic activity *in vitro* (Fatima et al. 2022). Albendazole exerts its antihelminthic action by disrupting the microtubule functions of parasites through the inhibition of β -tubulin polymerization. This interferes with essential cellular processes and inhibits glucose uptake, leading to depletion of glycogen stores. Ultimately, this leads to energy depletion, resulting in paralysis and eventual death of the parasite (Chai et al. 2021).

The results of the antihelminthic bioassay show that the extracts exhibited antihelminthic activity by inducing paralysis in the worms prior to causing death following exposure. This pattern of activity is consistent with findings from other *in vitro* studies, where paralysis precedes death as a key indicator of antihelminthic efficacy. Similar observations have been reported for ethanol extracts of leaves and stem extracts of *Physalis minima* against *Paramphistomum cervi* from cattle (Ahmed et al. 2022); methanol and aqueous extracts of the bark of *Lannea coromandelica* against *P. posthuma* and *Ascaridia galli* (Rajesh & Selvakumar 2022); and leaf and seed extract of *Cassia occidentalis* against *Haemonchus contortus* (Shafi et al. 2021).

The antihelminthic activity observed was dose-dependent: higher extract concentrations led to shorter paralysis and death times, whilst lower concentrations produced weaker effects (Table 2 and Table 3). This finding is consistent with reports from other studies, which have demonstrated a direct relationship between antihelminthic efficacy and extract concentration. For example, leaf extracts of *Amaranthus tricolor* showed dose-dependent activity against *Eisenia fetida* earthworms (Tripathi et al. 2023), whilst leaf extracts of *Phlogacanthus thyrsoiflorus* exhibited increasing efficacy with concentration against both mature and larval stages of *Hymenolepis diminuta* worms (Deori et al. 2024). Similarly, aqueous extracts of *Glycyrrhiza glabra* demonstrated dose-dependent inhibitory effects on nematodes of small ruminants (Maestrini et al. 2021). Collectively, these findings support the presence of a consistent dose-response relationship in plant-derived antihelminthic agents.

TABLE 1: Phytochemical screening of extracts.

Phytochemicals	Results		
	Leaves	Stem bark	Root bark
Alkaloids	+	+	+
Flavonoids	+	+	+
Terpenoids	–	–	–
Steroids	–	–	–
Saponins	+	+	+
Phenols	–	–	–
Tannins	+	+	+
Carbohydrates	–	–	–
Starch	–	–	–
Coumarins	–	–	–
Glycosides	–	–	–

+, detected; –, not detected.

Generally, the leaf and stem bark extracts exhibited significantly ($p < 0.05$) shorter paralysis and death times than MBZ (15 mg/mL) across all tested concentrations. In contrast, for the root bark extract, the 50 mg/mL and 100 mg/mL concentrations produced significantly ($p < 0.05$) shorter paralysis times (23.02 ± 1.61 min and 14.00 ± 2.16 min, respectively) compared to MBZ (15 mg/mL) (32.00 ± 0.82 min), whilst only the 100 mg/mL concentration resulted in a significantly shorter death time (57.67 ± 1.71 min) than MBZ (110.33 ± 1.70 min). Notably, the 25 mg/mL root extract concentration produced a mean death time of 411.67 ± 7.85 min, which is significantly longer ($p < 0.05$) than the 360-min threshold required to establish antihelminthic activity (Table 2 and Table 3).

Thus, findings from the present study suggest that the tested extracts exhibit promising antihelminthic activity by inducing paralysis and death of worms, similar to the reference drug albendazole. Albendazole exerts its antihelminthic effect by causing paralysis and subsequent death of worms, facilitating their expulsion in the faeces of humans and animals (Chai et al. 2021).

The phytochemical analysis conducted on the extracts indicated the presence of tannins, flavonoids, saponins and alkaloids (Table 1). The observed antihelminthic activity can be attributed to these bioactive compounds, either individually or synergistically. Alkaloids exert their antihelminthic activity primarily by interfering with the helminth's central nervous system, leading to paralysis. For example, the activity of *Argemone mexicana* (Mexican poppy) against *Strongyloides* spp. is attributed to the alkaloids berberine and protopine (López-Abán et al. 2025). Tannins bind with high affinity to the proline-rich collagen in nematode cuticle, increasing cuticle rigidity and disrupting flexibility, which impairs moulting and causes paralysis. For example, the antihelminthic activity of *Combretum mucronatum* against *Caenorhabditis elegans* is attributed to the

presence of tannins (Greiffer et al. 2022). Flavonoids act on helminths' nervous system by generating reactive oxygen species that disrupt redox balance and damage neural tissues. This oxidative stress interferes with normal physiological signalling, leading to paralysis and eventual death. For example, quercetin, a naturally occurring flavonoid, is reported to exert activity against *H. contortus*, a common nematode in small ruminants (Goel et al. 2023). Saponins disrupt mitochondrial function in helminths, resulting in reduced cellular energy, immobility and ultimately death. Saponins from plants in the families Fabaceae, Apiaceae, Aloaceae, Amaranthaceae, Zygophyllaceae, Rosaceae and Verbenaceae have been reported to exhibit significant antihelminthic activity (Rashid et al. 2024).

The results indicate that whilst the leaf extract exhibited shorter paralysis times compared to the stem bark extract, the stem bark extract produced shorter death times (Table 2 and Table 3). The root bark extract demonstrated the lowest activity amongst the extracts, as reflected by the longest paralysis and death times, which may be attributed to its low levels of bioactive compounds and correspondingly low extract yield of 0.87%. The shorter paralysis times observed with the leaf extract may be due to a higher concentration of bioactive agents that induce paralysis, whereas the shorter death times recorded for the stem bark extract may reflect the presence of greater levels of bioactive compounds that specifically promote worm mortality.

Conclusion

The study indicates that the ethanol extract of the leaves and stem of *C. alata* exhibited greater antihelminthic activity compared to the root extract, suggesting that these plant parts may serve as rich sources of bioactive compounds. The observed antihelminthic activity might be attributed to the presence of bioactive compounds within the classes of phytochemicals detected in the extracts, although the specific compounds remain to be identified. These findings support the folkloric use of *C. alata* as a plant-based antihelminthic agent.

However, further *in vitro* and *in vivo* investigations on the fractions of extracts and isolated compounds are necessary to better understand their antihelminthic properties and their underlying mechanisms of action. A key limitation of this study is the lack of identification of the specific compounds responsible for the observed activity. Nonetheless, this work provides a foundation for more targeted and detailed future research.

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TABLE 2: Paralysis times of extracts on *Pheretima posthuma*.

Extract concentration (mg/mL)	Time (min)			
	Leaves	Stem	Root	Normal saline (0.9% w/v)
25	5.65 ± 1.25	8.33 ± 1.25	41.00 ± 1.63	NA
50	4.70 ± 1.25	6.00 ± 0.82	23.02 ± 1.61	NA
100	3.68 ± 0.47	4.33 ± 0.47	14.00 ± 2.16	NA

Note: The paralysis times are given as mean $\pm$ s.d. ($n = 5$). The paralysis time of MBZ (15 mg/mL), the reference drug, was 32.00 ± 0.82 min.

MBZ, mebendazole; NA, no activity; s.d., standard deviation.

TABLE 3: Death times of extracts on *Pheretima posthuma*.

Extract concentration (mg/mL)	Time (min)			
	Leaves	Stem	Root	Normal saline (0.9% w/v)
25	24.00 ± 2.65	22.33 ± 1.70	411.67 ± 7.85	NA
50	22.30 ± 2.08	18.67 ± 1.25	286.67 ± 6.24	NA
100	18.60 ± 1.53	13.00 ± 1.61	57.67 ± 1.71	NA

Note: The death times are given as mean $\pm$ s.d. ($n = 5$). The death time of MBZ (15 mg/mL), the reference drug, was 110.33 ± 1.70 min.

MBZ, mebendazole; NA, no activity; s.d., standard deviation.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

CRediT authorship contribution

Michael W. Klu: Conceptualisation, Formal analysis, Supervision and Writing – original draft. John A. Apenteng: Conceptualisation, Formal analysis and Writing – review & editing. Mahmood B. Oppong: Formal analysis and Writing – review & editing. Lawrence A. Adutwum: Writing – review & editing. Michael Lartey: Writing – review & editing. Albert D. Gbenyo: Investigation and Methodology. Albert A. Asamoah: Investigation and Methodology. Kwabena F.M. Opuni: Writing – review & editing. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication, and take responsibility for the integrity of its findings.

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Data availability

The authors confirm that the data supporting this study and its findings are available within the article and its listed references.

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