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Research

Pumpkin Seeds *(Cucurbita moschata)* as a Sustainable Anthelmintic and Nutritional Intervention for Helminthiasis: A Literature Synthesis

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ABSTRACT

Helminthiasis remains a major public health issue in tropical and subtropical regions, particularly in low- and middle-income countries such as Indonesia. Soil-transmitted helminths (*Ascaris lumbricoides*, *Trichuris trichiura*, *Necator americanus*) contribute to malnutrition, anemia, stunting, and impaired cognitive development in children. While mass preventive drug administration (MPAD) with synthetic anthelmintics is effective, concerns about drug resistance highlight the need for alternative approaches. Pumpkin seeds (*Cucurbita moschata*), rich in cucurbitine and other nutrients, offer potential as a sustainable functional food with anthelmintic properties.
This literature review (2013–2023) analyzed in vitro, in vivo, and clinical studies from multiple countries, showing significant reductions in worm counts and egg outputs across various species, including *A. lumbricoides*, *T. trichiura*, *Hymenolepis nana*, *Haemonchus contortus*, and *Clonorchis sinensis*. Cucurbitine exerts neuromuscular paralysis on worms, while compounds such as flavonoids, phytosterols, and zinc improve hematological and nutritional status. Optimal effects occurred at doses ≥300 mg/kg extract or 20 g/day powder, with praziquantel co-administration enhancing efficacy to 90%. *C. moschata* demonstrates dual benefits as a natural anthelmintic and nutritional intervention, supporting its integration into helminthiasis control strategies alongside MPAD, sanitation, and nutrition programs. Further large-scale trials are needed to confirm efficacy and establish standardized protocols.

1. Introduction

Worm infestation remains a public health problem that poses a significant burden in low- and middle-income countries, particularly in tropical and subtropical regions such as Indonesia. These infections are commonly caused by soil-transmitted helminths (STH), including roundworms

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(*Ascaris lumbricoides*), hookworms (*Necator americanus*, *Ancylostoma duodenale*), and whipworms (*Trichuris trichiura*). An estimated one billion school-age children live in STH-endemic areas, with 69% of these residing in Asia (Pulla et al., 2014; Kunwar et al., 2016). Preschool children, aged 1–4 years, are at the highest risk of morbidity due to STH infections (World Health Organization [WHO], 2012; Shumbej et al., 2015).

In Indonesia, the prevalence of STH infection varies by region, ranging from 2.5% to 62.0% (Ministry of Health Republic of Indonesia [MHRI], 2017). This wide variation is influenced by environmental conditions, community behaviors, and access to sanitation and clean water. Although worm infections can affect all age groups, children are particularly vulnerable due to suboptimal hygiene practices and frequent contact with soil.

Worm infestation occurs when a human or animal is infected with parasitic worms. Worm eggs or larvae can enter the body orally or through the skin, multiply in the digestive tract, and may migrate to other organs (Ramadhian et al., 2018). The severity of symptoms depends on the number and type of worms, as well as the nutritional status of the host. The negative impacts on children include malnutrition, anemia, stunted growth, impaired cognitive development, and decreased learning ability (Oninla et al., 2010; Fürst et al., 2012; Sayasone et al., 2015). Chronic infections can lead to fatigue, reduced concentration, and poor school performance. In the long term, worm infections perpetuate the cycle of poverty by decreasing productivity in adulthood (Hotez et al., 2014).

Common clinical symptoms include abdominal pain, diarrhea, malnutrition, hepatosplenomegaly, gastrointestinal inflammation, anemia, vomiting, constipation, weight loss, anal itching, and, in severe cases, intestinal obstruction (Manke et al., 2015). Complications may include pneumonitis, blindness, and lymphedema. Environmental factors play a crucial role in transmission. Poor sanitation, unhygienic practices, and contamination of water with worm eggs are major risk factors (Campbell et al., 2014). Malnutrition further increases susceptibility to infection by weakening the immune system (Yap et al., 2014). Infections in pregnant women can also raise the risk of transmission to young children (Menzies et al., 2014).

A study in Thailand on Karen children reported a high prevalence of intestinal parasitic infections, which significantly impacted nutritional and hematological status, including anemia and iron deficiency (Yanola et al., 2018). Similar research in Nigeria and Bangladesh found associations between helminth infections and decreased serum vitamin A and zinc, as well as increased inflammatory markers (Akinwande et al., 2017; Ayse et al., 2019). Efforts to control helminth infections have included improved access to clean water, better sanitation, hygiene education, and nutritional supplementation. The WHO recommends Mass Preventive Drug Administration (MPAD) using albendazole or mebendazole once or twice annually for school-age children in endemic areas (Eshetu & Kefiyalew, 2019). In Indonesia, this policy targets children aged 1–12 years.

Although such programs effectively reduce prevalence, repeated use of synthetic anthelmintics raises concerns about drug resistance (Hotez et al., 2016). Reports of resistance in humans and animals have emerged in several countries, highlighting the need for alternative or combination strategies (Oladayo et al., 2019). Therefore, an integrated approach combining chemotherapy, environmental improvement (WASH), health education, and the development of natural-based anthelmintic products should be considered.

One promising candidate is pumpkin seeds (*Cucurbita moschata*), which contain cucurbitin—a bioactive compound with proven anthelmintic effects—along with proteins, healthy fats, vitamins, and minerals that can enhance nutritional status. These dual properties make pumpkin seeds an attractive option not only for reducing helminth burdens but also for addressing malnutrition in endemic communities. Their local availability, cultural acceptance, and potential for incorporation into dietary programs position them as a sustainable intervention for helminthiasis control.

This article synthesizes the latest scientific evidence regarding pumpkin seeds as a functional food with anthelmintic properties, highlighting their role in integrated helminth control programs in Indonesia and other endemic regions. The aim is to provide a comprehensive understanding of their efficacy, nutritional benefits, and potential applications in sustainable public health strategies.

2. Method

This article was compiled using a literature review design with the aim of assessing the latest scientific evidence regarding the potential of pumpkin seeds (Cucurbita moschata) as a functional food in combating worm infestation. This approach involved collecting, analyzing, and synthesizing research findings from various reliable sources, both national and international. The literature search was conducted through international databases such as PubMed, ScienceDirect, Scopus, and Google Scholar, as well as national databases such as Garuda and Neliti. The search also included manual searches of the bibliographies of relevant articles to ensure completeness.

Keyword combinations used in the search included "*worms*" *or* "*soil-transmitted helminths*" or "*intestinal worm infection,*" combined with "*pumpkin seeds*" or "*Cucurbita moschata,*" as well as the terms "*functional food*" and "*natural anthelmintic.*" Boolean operators (AND, OR) were used to expand or narrow the search results as needed.

Inclusion criteria for literature selection included publications within the last 10 years (2013–2023), written in Indonesian or English, original research, systematic reviews, or meta-analyses, and discussing topics related to helminth epidemiology, control strategies, the effects of pumpkin seeds on parasitic worms, or the nutritional benefits of pumpkin seeds. Articles were excluded if the full text was unavailable, did not contain verifiable primary data or analysis, or focused on non-relevant animal subjects that could not be extrapolated to humans.

The selection process involved screening titles and abstracts to assess relevance, followed by a full-text review of articles that passed the initial stage. Of the total literature found, only articles meeting the inclusion criteria were analyzed further. Data extracted included the study objectives, study design, study population or object, intervention or exposure, primary outcomes, and key findings. The analysis was conducted narratively (narrative synthesis) by comparing research results and assessing the consistency of findings between studies, with a particular focus on evidence of the anthelmintic effect of pumpkin seeds, their nutritional content, and their potential application in community worm control programs.

3. Results & Discussion

Based on the literature search and selection process, several studies were identified that investigated the anthelmintic and nutritional potential of pumpkin seeds (*Cucurbita moschata*) in various experimental and clinical settings. These studies were conducted across different countries, employed diverse research designs (in vitro, in vivo, and clinical trials), and targeted multiple helminth species. The interventions varied in form—extracts, powders, oils, and infusions—and were tested at different dosages. The following tables summarize the key characteristics, target parasites, and main findings of each study, providing a comprehensive synthesis of the evidence base.

Table 1. *Literature Synthesis on Pumpkin Seed (Cucurbita moschata) Intervention for Helminthiasis*

Author & Year	Study Location	Study Design / Subjects	Form & Dosage of Intervention	Helminth Species / Infection Model	Main Findings
Mwangi et al., 2015	Kenya	*In vivo* experiment on rats infected with *Hymenolepis nana*	Pumpkin seed extract 250–500 mg/kg BW	*Hymenolepis nana*	Significant reduction in intestinal worm count; 500 mg/kg BW dose was most effective.
Yadav et al., 2016	India	*In vitro* study	Ethanolic extract of pumpkin seeds 100–200 mg/ml	*Ascaris lumbricoides*	Paralytic activity and worm death within 3–5 hours; effect comparable to piperazine citrate.
Grzybek et al., 2016	Poland	*In vivo* experiment on sheep with gastrointestinal helminths	Feed supplemented with 5% pumpkin seeds	*Haemonchus contortus*	Reduction of egg counts in feces up to 68% after 14 days.
Adeleke et al., 2017	Nigeria	*In vivo* clinical trial on children aged 6–12 years (n=60)	Pumpkin seed powder 20 g/day for 7 days	*Ascaris lumbricoides*, *Trichuris trichiura*	Reduction of *A. lumbricoides* eggs by 75% and *T. trichiura* eggs by 65%; improved hemoglobin levels.
Feng et al., 2018	China	*In vitro* and *in vivo* study	Purified cucurbitine extract from pumpkin seeds 300 mg/kg BW	*Clonorchis sinensis*	Rapid paralytic effect; combination with praziquantel increased effectiveness up to 90%.
Olamide et al., 2020	Ghana	*In vivo* experiment on rats infected with *Necator americanus*	Pumpkin seed oil 1 ml/100 g BW orally	*Necator americanus*	Reduction of adult worms >80% and improved hematological status.

A literature review (Table 1) indicates that pumpkin seeds (Cucurbita moschata) have significant potential as an anthelmintic agent against various worm species. In vivo studies by Mwangi et al. (2015) in Kenya using a Hymenolepis nana infection model in mice showed a significant reduction in intestinal worm counts, particularly at the most effective dose of 500 mg/kg body weight. In vitro studies by Yadav and Tangpu (2016) in India using an ethanol extract of pumpkin seeds (100–200 mg/ml) against Ascaris lumbricoides revealed paralysis and worm death within 3–5 hours, comparable to the effects of piperazine citrate.

In Poland, Grzybek et al. (2016) conducted in vivo tests on sheep infected with Haemonchus contortus with a diet supplemented with 5% pumpkin seeds and reported a reduction in egg counts in feces of up to 68% after 14 days of treatment. Adeleke et al. (2017) in Nigeria conducted a clinical trial in children aged 6–12 years (n = 60) administering 20 g of pumpkin seed powder daily for 7 days, and found a 75% reduction in A. lumbricoides and 65% in T. trichiura eggs, accompanied by an increase in hemoglobin levels. Feng et al. (2018) in China evaluated a pure cucurbitine extract from pumpkin seeds (300 mg/kg body weight) against Clonorchis sinensis and reported rapid paralysis; combination with praziquantel increased the effectiveness to 90%. A study by Olamide et al. (2020) in Ghana on mice infected with Necator americanus using pumpkin seed oil (1 ml/100 g body weight orally) showed a reduction in adult worm counts of more than 80% and improved hematological status.

The results of this literature synthesis indicate that Cucurbita moschata has a broad spectrum of activity against various helminth species, both nematodes and trematodes. Its effectiveness may be explained by the presence of cucurbitine, a bioactive compound reported to have a neuromuscular paralytic effect on worms, thus facilitating their expulsion from the host (Feng et al., 2018). In general, in vivo trials (Mwangi et al., 2015; Grzybek et al., 2016; Adeleke et al., 2017; Olamide et al., 2020) have demonstrated significant effectiveness in reducing the burden of infection and improving the host's nutritional or hematological status. In vitro trials (Yadav & Tangpu, 2016; Feng et al., 2018) support evidence of a direct mechanism of action against worms through paralytic and larvicidal effects.

Variations in effectiveness between studies are likely due to differences in dosage form (extract, powder, oil, feed), dose, duration of administration, and target species. High doses (≥ 300 mg/kg body weight) appear to provide more consistent results in reducing worm and egg counts, although solid dosage forms such as seed powder (Adeleke et al., 2017) are also effective in humans. This is relevant for community-based applications because pumpkin seed powder can be produced locally, is easily consumed, and is relatively safe.

The combination of cucurbitine with synthetic anthelmintic drugs such as praziquantel has been shown to increase efficacy (Feng et al., 2018), thus offering an alternative strategy to address the potential for resistance to synthetic anthelmintics that has been reported (Hotez et al., 2016; Oladayo et al., 2019). Furthermore, pumpkin seeds contain protein, healthy fats, vitamins, and minerals, which may contribute to improving the nutritional status of children in endemic areas (Akinwande et al., 2017; Ayse et al., 2019). These findings support recommendations for an integrated approach to helminthiasis control (Campbell et al., 2014; Eshetu & Kefiyalew, 2019), utilizing local resources such as pumpkin seeds as a safe, sustainable, and functional anthelmintic food with the potential to improve nutritional security in endemic areas.

Table 2. *Comprehensive Literature Synthesis on Pumpkin Seeds (Cucurbita moschata) as Functional Food and Intervention for Helminthiasis Control*

Author & Year	Study Location	Study Design / Subjects	Form & Dosage / Mode of Administration	Helminth Species / Infection Model	Functional Components	Main Findings
Mwangi et al., 2015	Kenya	*In vivo* experiment on rats infected	Pumpkin seed extract 250–500 mg/kg BW	*Hymenolepis nana*	Cucurbitine, flavonoids	Significant reduction in worm count; highest effect at 500 mg/kg BW.
Yadav et al., 2016	India	*In vitro* study	Ethanolic extract 100–200 mg/ml	*Ascaris lumbricoides*	Cucurbitine, phytosterols	Paralysis and worm death within 3–5 hours; comparable to piperazine citrate.
Grzybek et al., 2016	Poland	*In vivo* on sheep with GIT helminths	Feed with 5% pumpkin seeds	*Haemonchus contortus*	Cucurbitine, unsaturated fatty acids	68% reduction in fecal egg counts after 14 days; improved hematology.
Adeleke et al., 2017	Nigeria	Clinical trial (n=60 children, 6–12 yrs)	Pumpkin seed powder 20 g/day for 7 days	*A. lumbricoides*, *T. trichiura*	Cucurbitine, protein, zinc	Egg count reduction: 75% (*A. lumbricoides*), 65% (*T. trichiura*); increased hemoglobin.
Feng et al., 2018	China	*In vitro* & *in vivo*	Purified cucurbitine extract 300 mg/kg BW	*Clonorchis sinensis*	Cucurbitine	Rapid paralytic effect; enhanced efficacy with praziquantel (90%).
Olamide et al., 2020	Ghana	*In vivo* on rats infected with *N. americanus*	Pumpkin seed oil 1 ml/100 g BW orally	*Necator americanus*	Omega-6 fatty acids, tocopherol	>80% reduction in adult worms; improved hematological status.
Purnama sari, 2014	Indonesia (UB, Malang)	*In vitro* on *Ascaris suum*	Aqueous extract 30–50% concentration	*Ascaris suum*	Cucurbitine	LC_{100} = 49.99%; LT_{100} at 50% = 10.55 h; significant anthelmintic effect.

Ganestya , 2011	Indonesia (UNAIR)	*In vitro* on *Ascaris suum*	Infusion of pumpkin seeds (various conc.)	*Ascaris suum*	Tannins, cucurbitine	Higher mortality rate than control group.
Zakiah et al., 2020	Indonesia (Aceh)	*In vitro* on *Ascaridia galli*	Ethanolic extract 25, 50, 100 mg/ml	*Ascaridia galli*	Cucurbitine	60% mortality (25 mg/ml) and 80% mortality (50–100 mg/ml) after 36 h.

The literature review in Table 2 shows that pumpkin seeds (*Cucurbita moschata*) have dual potential as an anthelmintic agent and a functional food to support helminthiasis control. Their effectiveness has been tested through various research designs, both *in vitro* and *in vivo*, and in human clinical trials, using various dosage forms such as pumpkin seed extract, powder, oil, and infusion.

An *in vivo* study by Mwangi et al. (2015) in Kenya on mice infected with *Hymenolepis nana* using pumpkin seed extract at doses of 250–500 mg/kg body weight, containing cucurbitine and flavonoids, showed a significant reduction in worm counts, with the highest effect at a dose of 500 mg/kg body weight. Yadav and Tangpu (2016) in India conducted an *in vitro* test using pumpkin seed ethanol extract (100–200 mg/ml) against *Ascaris lumbricoides*, containing cucurbitine and phytosterols, and found that the effect was comparable to piperazine citrate, resulting in paralysis and worm death within 3–5 hours.

Grzybek et al. (2016) in Poland reported that supplementing the feed of sheep infected with *Haemonchus contortus* with 5% pumpkin seeds, rich in cucurbitine and unsaturated fatty acids, reduced the number of eggs in the feces by up to 68% after 14 days and improved the hematological profile. Meanwhile, Adeleke et al. (2017) in Nigeria conducted a clinical trial in children aged 6–12 years, administering 20 g of pumpkin seed powder daily for 7 days. The results showed a 75% reduction in the number of *A. lumbricoides* and 65% in *T. trichiura* eggs, accompanied by an increase in hemoglobin levels, likely influenced by the protein and zinc content of pumpkin seeds.

Feng et al. (2018) in China evaluated a pure cucurbitine extract at 300 mg/kg body weight against *Clonorchis sinensis* and found rapid paralysis. Combination with praziquantel increased the effectiveness to 90%, highlighting the potential synergistic use of natural ingredients and synthetic drugs. Olamide et al. (2020) in Ghana reported that pumpkin seed oil, which contains omega-6 fatty acids and tocopherol, reduced the number of adult *Necator americanus* worms by more than 80% and improved hematological status in laboratory mice.

Furthermore, several studies in Indonesia have further strengthened the evidence for the effectiveness of pumpkin seeds. Purnamasari (2014) from Brawijaya University, Malang, reported that pumpkin seed water extract at a concentration of 30–50% against *Ascaris suum* had an LC_{100} value of 49.99% and an LT_{100} at a concentration of 50% within 10.55 hours, indicating a significant anthelmintic effect. Ganestya (2011) from Airlangga University demonstrated that pumpkin seed infusion at various concentrations resulted in higher mortality rates for *A. suum* worms compared to the control group, which was attributed to the tannin and cucurbitine content. Research by Zakiah et al. (2020) in Aceh using ethanol extract of pumpkin seeds against *Ascaridia galli* showed 60% mortality at a concentration of 25 mg/ml and 80% at a concentration of 50–100 mg/ml after 36 hours.

This evidence suggests that the effectiveness of *Cucurbita moschata* may stem from its key component cucurbitine, which plays a role in disrupting the worm's neuromuscular system, causing paralysis and death. Additionally, other components such as flavonoids, phytosterols, unsaturated fatty acids, tannins, proteins, zinc, and tocopherols provide additional benefits, including improved nutritional status and hematological outcomes in the host.

The findings from these studies reinforce the concept that pumpkin seeds can be part of an integrated helminthiasis control strategy, complementing public health interventions such as mass drug administration (Eshetu & Kefiyalew, 2019) and improved sanitation (Campbell et al., 2014). Their advantages include local availability, safe consumption, high nutritional content, and the potential for use alone or in combination with synthetic anthelmintics, which may help address drug resistance issues (Hotez et al., 2016; Oladayo et al., 2019).

Although scientific evidence from various studies demonstrates the effectiveness of *Cucurbita moschata* as both an anthelmintic agent and a functional food, most of the current research has been conducted at a laboratory scale (*in vitro* and *in vivo*) with limited populations. Therefore, large-scale clinical trials on humans across different age groups and geographic conditions are needed to confirm its efficacy, long-term safety, and optimal dosage. Furthermore, since studies have used different dosage forms (extracts, powders, oils, infusions), standardization of extraction methods and formulations is necessary to ensure consistent and comparable results.

From a public health program perspective, integrating pumpkin seeds as a nutraceutical intervention requires a multisectoral approach, including nutrition education, local production support, and community engagement. The utilization of pumpkin seeds can also contribute to community economic empowerment through cultivation and processing into ready-to-consume products. However, to ensure sustainability, cost–benefit evaluations, supply chain analyses, and long-term impact assessments on nutritional status and helminthiasis prevalence reduction are essential.

4. Conclusion

Pumpkin seeds (Cucurbita moschata) have been shown to have dual potential as a natural anthelmintic agent and a functional food that supports helminthiasis control. Results from various in vitro, in vivo, and clinical trials demonstrate significant effectiveness in reducing the infection burden of various worm species, including Ascaris lumbricoides, Trichuris trichiura, Hymenolepis nana, Haemonchus contortus, Necator americanus, Clonorchis sinensis, Ascaris suum, and Ascaridia galli.

The main bioactive component, cucurbitine, acts as a neuromuscular paralytic agent, facilitating the expulsion of worms from the host body. Supporting compounds such as flavonoids, phytosterols, unsaturated fatty acids, tannins, proteins, zinc, and tocopherols provide additional benefits in the form of improved nutritional and hematological status. Effectiveness is consistently observed at doses of ≥300 mg/kg body weight for the extract, equivalent to 20 g of seed powder per day in humans, and can be enhanced through combination with synthetic anthelmintics such as praziquantel.

With its local availability, safe consumption, high nutritional value, and potential for both single and combined use, pumpkin seeds have the potential to be part of an integrated helminthiasis control strategy, including mass drug administration programs, improved sanitation, health education, and nutritional interventions. Utilizing this local resource also supports a sustainable approach to addressing drug resistance and improving public health in areas endemic for helminthiasis, particularly in children.

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