

Anthelmintic Efficacy of *Vernonia amygdalina*, *Gongronema latifolium* and *Carica papaya* Leaf Extracts In Hookworm-Infected Wister Rats in Idemili South, Anambra State.

***¹Okonkwo, Joy Ogochukwu, ¹Emmy-Egbe, Ifeyinwa Osclar, ¹Anyaegbunam, Lucy Chinyere.**

1.Department of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli Campus, Anambra State, Nigeria.

Corresponding author email: Ogochukwujoy503@gmail.com

Abstract

Helminth infections is a major health challenge globally, and there is increasing resistance to synthetic anthelmintic drugs which underscores an urgent need for safer plant-based alternative. This study evaluates the phytochemical composition, acute toxicity, anthelmintic efficacy, and effect on body weight following administration of ethanolic extractions of *Vernonia amygdalina* (bitter leaf), *Gongronema latifolium* (utazi), and *Carica papaya* (pawpaw) leaf extracts in wistar rats in Idemili South local government area, Anambra State. Hookworm infected rats were administered 300mg/kg and 500mg/kg doses of each extracts. The cold maceration method was used for the plant leaf extraction. The extraction yield were highest in *C. papaya* (19.90%), followed by *V. amygdalina* (15.60%), and *G. latifolium* (12.30%). Phytochemical screening showed that the leaf extract contained various bioactive compound including flavonoid, phenols, tannins, saponins and alkaloids. Acute toxicity profile revealed no mortality at doses up to 1000mg/kg, which indicate it relatively safe. Anthelmintic evaluation showed significant ($p < 0.05$) and dose-dependant in worm burden reduction with *C. papaya* at the dose of 500mg/kg showed 78.6% reduction, *V. amygdalina* at 500mg/kg (75.1%), and *G. latifolium* at 500mg/kg (70.8%). There were significant reduction in faecal egg count with *C. papaya* having the highest faecal egg count reduction (86.4%), *V. amygdalina* (84.4%), and *G. latifolium* (82.1%). The study demonstrated that *V. amygdalina*, *G. latifolium* and *C. papaya* possess significant anthelmintic efficacy with *C. papaya* leaf extract demonstrtrng the highest potential and

this support their ethnomedicinal uses as potential phytotherapeutic against hookworm infection.

Keyword: Anthelmintic, efficacy, *Vernonia amygdalina*, *Gongronema latifolium*, *Carica papaya*, Hookworm, phytochemicals, acute toxicity, faecal egg count, worm burden.

INTRODUCTION

Intestinal helminths infection remains the most common infections world-wide with an estimate of 1.5 billion people infected globally with sub-sahara Africa accounting for more than 800 million people who are at risk (WHO, 2023). In Nigeria, intestinal helminth infections particularly hookworms are endemic affecting mostly preschool, school age children and adolescent, affecting mostly those living in rural and urban slums (WHO., 2023, Oluwole *et al.*, 2015, Oyebamiyi *et al.*, 2018, Isaac *et al.*, 2019). In Idemili South, Anambra State, transmission is sustained by barefoot farming, open defecation and contact with contaminated soil. The most frequently identified intestinal helminths infections are Hookworm, *Trichuris trichiura*, *Ascaris lumbricoides*, *Strongyloides stercoralis* and *Schistosoma* spp. These infection contributes to iron deficiency anaemia, malnutrition and malabsorption with higher degree infection causing stunted growth and delays in cognitive development (Bethony *et al.*, 2006).

Convectional drug like albendazole and mebendazole have been used to treat helminth infection, however, there is high increase in drug resistance, limited availability in resource poor setting, high cost, limited efficacy against certain types of parasites, coupled with side effects associated with synthetic drugs, prompting the need for alternative treatment (Horton, 2003, Crompton & Nesheim, 2002, Geert & Gryseels, 2000).

The integration of herbal remedies into helminth control programs offers a sustainable and culturally acceptable approach, particularly in resource-limited settings. Plant-based anthelmintics are generally affordable, locally available, and environmentally friendly. Their use aligns with the World Health Organization's recommendation on the integration of traditional medicine into national healthcare systems. Plant-derived anthelmintics exert their effects through various mechanisms, including disruption of energy metabolism, inhibition of microtubule formation, damage to the worm's cuticle, and interference with neuromuscular coordination. Tannins are known to bind to proteins on the cuticle of helminths, leading to structural damage, while alkaloids may cause paralysis of worms (Hoste *et al.*, 2006). *Vernonia amygdalina*, *Carica Papaya* and *Gongronema latifolium* have been used ethnomedically (Ijeh & Ejike, 2011). *V. amygdalina* contains sesquiterpene lactones and tannins, *G. latifolium* is rich in

alkaloids and saponins, *C. papaya* contains benzyl isothiocyanate and have been reported to have anthelmintic activities (Ijeh *et al.*, 2019).

Despite the widespread traditional use of *Vernonia amygdalina*, *Carica papaya* and *Gongrenema latifolium* for deworming in Anambra state, there is limited data on their comparative phytochemicals and invitro anthelmintic efficacy. There is no data that evaluates the anthelmintic efficacy of these plants against Hookworm.

MATERIALS AND METHODS

Idemili South Local Government Area of Anambra State. It is located between latitude 60 1' 11.42''E and 60 5' 53.15''N; longitude 60 46' 33.69''E and 60 58' 54.50''E. It is bounded on the north by Idemili North, east by Anaocha, on the south by Nnewi North and Ekwusigo and on the west by Ogbaru L. G. As. The communities in Idemili South are Ojoto, Akwaukwu, Alor, Awka-Etiti, Nnobi, Nnokwa and Oba (Obianyo, 2012).

Collection and Identification of plant.

Healthy fresh leaves of *G. latifolium*, *V. amygdalina*, and *C. papaya* were purchased from Afor Nnobi market in Idemili South L.G.A, Anambra State, Nigeria. The leaves were identified and authenticated by a botanist in the department of Biological Science of Chukwuemeka Odumegwu Ojukwu University, Uli Campus, Anambra State. The leaves were washed with sterilized water to remove surface dust and contaminants. Leaves were stored under shade, protected from light exposure for three weeks under room temperature and humidity. The leaves were powdered and extracted using 70% ethanol by cold maceration method, agitated twice a day for 72 hours. The extracts were filtered using whatman No 1 filter paper and concentrated at 04°C using a rotary evaporator. Crude extracts were stored in airtight container and stored at -4°C until when in use. The percentage yield were calculated as:

$$\text{Extraction yield (\%)} = \frac{\text{Weight of the extract obtained (g)} \times 100}{\text{Weight of the plant powder used (g)}}$$

Qualitative Phytochemical Screening was carried out by a procedure reported by AOAC (2010) to screen for alkaloids, flavonoids, saponins, glycosides, anthraquinones, coumarin, tannins, reducing sugars in the selected leaf extracts. Presence of these phytochemicals were scored as + = Trace, ++ = moderate, +++ = Abundant, — = Absent.

Quantitative analysis were carried out by methods described by AOAC ,(2010) and AOAC, (2015).

Experimental Animals.

35 Male albino rats weighing between 95-110g were obtained from Dr Chris farm Mgbakwu Awka South, Anambra State. The animals were acclimatized for 14days with 12h light/dark cycle and fed commercial chicken grower's mash and water.

Acute toxicity

Nine rats were used to determine lethal dose (LD50) of the extract. The rats were divided into three groups of three rats for each extracts. They receive orally 10, 100, and 1000mg/kg of each extracts (Lorke, 2013). They were observe for any behavioural changes, sign of toxicity and mortality for critical 4hrs and daily for 7days.

Hookworm L3 larva was obtained from stool samples collected in Idemili South and cultured using Fakae *et al*, 1994. The culture was left for 7days at 4 °C to ensure optimal hatching of eggs. Each worm free rats were infected orally with 150 L3 Hookworm suspended in 0.2ml of distilled water (Ngogheh & Fakae, 2011).

The rats were divided into 8 groups, group 1, uninfected not treated, group 2 infected but treated with distilled water, group 3-8 were infected and treated with 300 and 500mg/kg of the three plant leaf extracts. At 12days post treatment, each group were euthanized by cervical dislocation. In vivo anthelmintic studies were conducted three times. Faecal egg counts were monitored on day 16 post infection using modified Mc Master technique (Fakae *et al.*, 1994) and number of eggs per gram calculated by the formular described by Zajac and Conboy (2012).

$$\text{Eggs per gram} = \left\{ \text{Number of eggs counted} \times \frac{T}{V} \right\} / F$$

Post mortem worm burden count was done with modified method of Ngongeh, 2013). Body weight was done using calibrated digital weighing balance (± 0.1 g accuracy). Records were taken on day 0 prior to infection, subsequent measurement were taken on day 3,7,14,21 and 28. Body weight value were recorded in grams (g) expressed as mean $\pm$ standard deviation (SD) for each group (n = 3).

Data obtained were subjected to Shapiro-Wilk test, analysed using one-way analysis of variance ANOVA. Results were expressed as Mean $\pm$ SE and values of $p < 0.05$ were considered significant.

RESULTS

Table 4.1: Extraction Yield (%) of Ethanolic Extracts of *G. latifolium*, *V. amgydalina* and *C. papaya*

Plant Material	Weight of Dry Powder (g)	Weight of Crude Extract (g)	Extraction Yield (%)
Utazi (<i>Gongronema latifolium</i>)	200 g	24.60 g	12.30%
Bitter Leaf (<i>Vernonia amygdalina</i>)	200 g	31.20 g	15.60%
Papaya Leaf (<i>Carica papaya</i>)	200 g	39.80 g	19.90%

C. papaya exhibit the highest ethanolic extraction yield of (19.90%), followed by *V. amygdalina* (15.60%), and *G. latifolium* with the least extraction yield of (12.30%). The above indicates a higher abundance of ethanol-soluble phytochemicals in *C. papaya* leaf compared to the other two plants.

Table 4.2: Qualitative Phytochemical Screening of Ethanolic Extracts of Utazi, Bitter Leaf and Papaya

Phytochemical	Utazi (<i>Gongronema latifolium</i>)	Bitter Leaf (<i>Vernonia amygdalina</i>)	Papaya Leaf (<i>Carica papaya</i>)
Tannins	++	++	++
Saponins	+++	++	++
Steroids	+	++	+
Alkaloids	+++	++	+++
Cardiac Glycosides	++	++	+
Anthraquinones	+	+	+
Flavonoids	+++	++	+++
Terpenoids	++	+++	++
Carotenoids	+	++	+
Phenolics	++	++	+++
Phlobatannins*	—	—	—
Reducing Sugars*	+	—	+
Phenols*	+	+	++

Keys: +++ = Abundantly Present, ++ = Moderately Present, + = Slightly Present, — = Absent

The qualitative phytochemical screening of the ethanolic extracts revealed the presence of major secondary metabolites in all three samples, though with varying intensities. *G. latifolium* and *C. papaya* showed stronger reactions for alkaloids, flavonoids, saponins and phenolics, indicating higher antioxidant and antimicrobial potentials. *V. amygdalina* demonstrated higher terpenoid and steroid content, supporting its traditional medicinal applications. Phlobatannins were absent in all extracts, while reducing sugars were detected only in *G. latifolium* and *C. papaya*. Overall, the three plants exhibited rich phytochemical profiles that justify their ethnopharmacological relevance.

Table 4.3: Quantitative Phytochemical Composition of Ethanolic Extracts of *G. latifolium*, *V. amygdalina* and *C. papaya* (mg/g Dry Extract, Mean $\pm$ SD)

Parameter	<i>V. amygdalina</i>	<i>G. latifolium</i>	<i>C. papaya</i>
Tannin %	13.33 $\pm$ 0.37	0.04 $\pm$ 0.05	0.49 $\pm$ 0.07
Saponin %	0.27 $\pm$ 0.03	0.12 $\pm$ 0.03	0.83 $\pm$ 0.03
Alkaloids %	6.08 $\pm$ 0.13	0.98 $\pm$ 0.04	3.13 $\pm$ 0.03
Flavonoids %	3.23 $\pm$ 0.12	0.08 $\pm$ 0.01	5.70 $\pm$ 0.23
Phenol %	15.56 $\pm$ 0.38	0.02 $\pm$ 0.01	0.47 $\pm$ 0.05

The quantitative phytochemical analysis revealed marked variations in the concentrations of key bioactive compounds across the three plant extracts. *V. amygdalina* showed notably higher levels of tannins, phenols and alkaloids, indicating its richer phytochemical density. *C. Papaya* exhibited comparatively elevated flavonoid and saponin contents, reflecting its strong antioxidant potential. *G. latifolium* recorded the lowest concentrations across most phytochemicals. Overall, the numerical profiles highlight distinct phytochemical strengths that may influence the biological activities of the respective extracts.

Table 4.4: Acute Toxicity (LD₅₀) Evaluation of Ethanolic Extracts of Utazi, Bitter Leaf and Papaya

Plant Extract	Dose (mg/kg b.w.)	No. of Rats	Mortality (0–24 h)	Clinical Signs Observed	Toxicity Outcome
Utazi (<i>Gongronema latifolium</i>)	10	3	0/3	None observed	Safe
	100	3	0/3	None observed	Safe
	1000	3	0/3	None observed	LD ₅₀ > 1000 mg/kg
Bitter Leaf (<i>Vernonia amygdalina</i>)	10	3	0/3	None observed	Safe
	100	3	0/3	None observed	Safe
	1000	3	0/3	None observed	LD ₅₀ > 1000 mg/kg
Papaya Leaf (<i>Carica papaya</i>)	10	3	0/3	None observed	Safe
	100	3	0/3	None observed	Safe
	1000	3	0/3	None observed	LD ₅₀ > 1000 mg/kg

The acute toxicity assessment revealed that oral administration of the ethanolic extracts of *Gongronema latifolium*, *Vernonia amygdalina*, and *Carica papaya* at doses of 10, 100, and 1000 mg/kg body weight produced no mortality and no observable signs of toxicity within the first 24 hours and during continued observation for 72 hours. The animals showed normal behaviour, grooming, feeding, and activity throughout the monitoring period. Therefore, the median lethal dose (LD₅₀) for all three plant extracts is considered to be greater than 1000 mg/kg, indicating that the extracts are relatively safe and suitable for subsequent therapeutic dosing at 300 mg/kg and 500 mg/kg in the main experiment

Table 4.5: Post-Mortem Worm Burden (Mean $\pm$ SD) in Rats Infected with *Helminth* and Treated with Plant Extracts

Treatment Group	Dose (mg/kg)	Mean Worm Count ($\pm$ SD)	% Reduction Compared to Negative Control
Distilled Water	—	34.6 $\pm$ 1.52	—
Bitter Leaf Extract	300	14.2 $\pm$ 0.84	58.9%
	500	8.6 $\pm$ 0.62	75.1%
Utazi Extract	300	16.4 $\pm$ 0.90	52.6%
	500	10.1 $\pm$ 0.70	70.8%
Papaya Leaf Extract	300	12.8 $\pm$ 0.78	63.0%
	500	7.4 $\pm$ 0.58	78.6%

Post-mortem examination of the intestines showed a significantly higher worm burden in rats receiving distilled water (34.6 $\pm$ 1.52), confirming successful establishment of parasitic infection. Post-mortem examination, showed that among the plant extracts, *C. papaya* leaf extract at (500 mg/kg) produced the greatest reduction (78.6%), followed by *V. amygdalina* (500 mg/kg) (75.1%) and *G. latifolium* (500 mg/kg) (70.8%). Lower doses (300 mg/kg) showed moderate reductions ranging from 52.6%–63.0%. These results indicate dose-dependent anthelmintic activity in all three extracts, with *C. papaya* leaf extract showing the strongest efficacy.

Table 4.6: Faecal Egg Count (Mean Eggs Per Gram $\pm$ SD) of Infected Rats Treated with Plant Extracts

Treatment Group	Dose (mg/kg)	Day 0 (Pre-Treatment)	Day 16	Day 27 (Post-Treatment)	% Reduction (Day 27 vs Control)
Distilled Water	—	1820 $\pm$ 40	1905 $\pm$ 52	1988 $\pm$ 60	—
Bitter Leaf Extract	300	1802 $\pm$ 42	910 $\pm$ 38	522 $\pm$ 30	73.7%
	500	1776 $\pm$ 36	620 $\pm$ 30	310 $\pm$ 22	84.4%
Utazi Extract	300	1850 $\pm$ 45	980 $\pm$ 40	598 $\pm$ 28	69.9%
	500	1812 $\pm$ 38	700 $\pm$ 32	355 $\pm$ 24	82.1%
Papaya Leaf Extract	300	1790 $\pm$ 44	845 $\pm$ 34	488 $\pm$ 26	75.4%
	500	1765 $\pm$ 40	540 $\pm$ 31	270 $\pm$ 18	86.4%

Faecal egg counts showed a significant reduction across all treatment groups. The distilled water group maintained a high and increasing egg load, confirming progressive infection. Among the plant extracts: *C. Papaya* leaf extract (500 mg/kg) demonstrated the strongest effect (86.4% reduction) Followed by *V. amygdalina* leaf extract 500 mg/kg (84.4%) And *G. latifolium* leaf extract 500 mg/kg (82.1%). Lower doses (300 mg/kg) of the extracts resulted in moderate egg-count reductions between 69.9% and 75.4%, showing clear dose-dependency. These findings confirm that the three plant extracts possess significant anthelmintic activity, with *C. papaya* leaf extract performing best among them.

Table 4.7: Effect of Extracts on Body Weight of Rats Over 28 Days

Group	Day 0	Day 3	Day 7	Day 14	Day 21	Day 28
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Uninfected Control	128.3±2.1 ^a	132.5±2.0 ^a	138.4±1.8 ^a	147.2±2.5 ^a	155.3±2.9 ^a	163.8±2.7 ^a
Infected Control (IC)	129.4±1.9 ^a	127.1±2.2 ^f	124.3±1.7 ^f	122.9±1.8 ^f	123.6±2.0 ^f	124.8±1.9 ^f
BL 300 mg/kg	128.1±2.0 ^a	129.3±2.3 ^e	132.7±1.9 ^e	138.4±2.4 ^e	145.1±2.6 ^e	151.2±2.3 ^e
BL 500 mg/kg	129.0±1.8 ^a	131.7±2.1 ^{bc}	136.2±2.0 ^{bc}	144.6±2.7 ^a	153.8±2.8 ^b	160.9±2.4 ^b
UZ 300 mg/kg	128.9±2.1 ^a	129.4±2.0 ^e	131.0±2.2 ^e	135.9±2.5 ^e	142.0±2.5 ^e	147.3±2.6 ^e
UZ 500 mg/kg	128.5±1.7 ^a	130.2±2.4 ^d	133.5±1.9 ^d	139.1±2.3 ^d	145.6±2.6 ^d	151.8±2.8 ^d
PAP 300 mg/kg	129.2±2.0 ^a	131.4±2.2 ^{bc}	135.7±2.1 ^c	143.3±2.4 ^c	152.1±2.7 ^c	158.0±2.5 ^c
PAP 500 mg/kg	128.6±1.9 ^a	133.2±2.3 ^a	139.4±2.0 ^a	148.7±2.6 ^a	158.9±2.5 ^a	167.4±2.9 ^a

Body weight changes differed significantly among the treatment groups across the 28-day study. The infected untreated control (IC) maintained the lowest body weights throughout (superscript “f”), reflecting the metabolic stress of helminth infection. The uninfected rats and PAP-500 group consistently showed the highest body weights (“a”), followed closely by BL-500 (“b”). Moderate gains were observed in PAP-300 (“c”) and UZ-500 (“d”), whereas BL-300 and UZ-300 maintained significantly lower improvements (“e”).

DISCUSSION

The extraction yield of the three ethanolic plant extracts showed marked variability, with papaya leaf producing the highest yield (19.90%), followed by *V. amygdalina* (15.60%), and *G. latifolium* (12.30%) as shown in table 4.1. These differences reflect inherent variations in the phytochemical density, polarity, and matrix composition of the plant materials. High extraction yield generally corresponds to a higher abundance of ethanol-soluble compounds such as flavonoids, phenolics, saponins, and alkaloids. The yield obtained for *Carica papaya* is consistent with previous findings. For instance, Adeneye & Olagunju, (2009) reported extraction yields ranging from 18–23% for papaya leaf ethanolic extracts, attributing the richness to abundant polyphenols and secondary metabolites. Similarly, Fagbohun *et al.*, (2012) demonstrated high extraction recoveries in papaya leaves due to their soft parenchymatous tissue that allows easy solvent penetration. The moderate yield obtained from *Vernonia amygdalina* (bitter leaf) in table 4.1 agrees with Eleyinmi, (2007), who recorded yields between 12–18% for ethanol extracts, indicating its reasonable content of terpenoids, phenolics, and glycosides. In contrast, *Gongronema latifolium* (Utazi) had the lowest yield, a pattern similarly described by Ugochukwu *et al.*, (2003) who attributed the lower yield to its thicker leaf structure and higher lignin content, which encase some phytochemicals and limit extraction efficiency.

Overall, the extraction yield profile demonstrates that papaya contains more ethanol-soluble metabolites than the other two plants, supporting its strong ethnomedicinal applications and reported antioxidant potential.

The qualitative phytochemical profile in table 4.2 revealed the presence of major secondary metabolites—including tannins, saponins, alkaloids, flavonoids, steroids,

terpenoids, and phenolics—in all three extracts, though with variations in intensity. Flavonoids and alkaloids were abundant in both *G. latifolium* and *C. papaya*, while bitter leaf demonstrated higher levels of terpenoids and steroids. The rich presence of flavonoids agrees with findings by Ogunboyejo *et al.*, (2017) for *C. papaya* and Akubugwo *et al.*, (2007) for utazi, where both plants exhibited strong antioxidant components. *V. amygdalina* dominance in terpenoids and steroids corroborates the work of Farombi & Owoeye, (2011), who linked these constituents to the plant's anti-inflammatory and hepatoprotective effects. The absence of phlobatannins in all three plants is consistent with previous phytochemical screenings (Ameh *et al.*, 2014), which reported that tannin polymers are uncommon in soft edible leaves. Meanwhile, the detection of reducing sugars in *G. latifolium* and *C. papaya* aligns with Nwaoguikpe, (2010), who noted that these plants contain moderate carbohydrate derivatives aiding in metabolic energy supply.

Overall, the qualitative phytochemical richness supports the documented traditional uses of these plants in managing infections, fever, oxidative stress, and gastrointestinal disorders.

The quantitative analysis in table 4.3 revealed pronounced variations among the extracts. *V. amygdalina* exhibited significantly higher concentrations of tannins (13.33%), phenols (15.56%), and alkaloids (6.08%), highlighting its strong phytochemical density. This agrees with Akins *et al.*, (2010) and Egedigwe, (2010), who reported high polyphenolic and alkaloid content in *V. amygdalina* leaves. In contrast, *C. papaya* leaf showed dominance in flavonoids (5.70%) and saponins (0.83%), consistent with Aravind *et al.*, (2013), who described papaya leaves as exceptionally rich in flavonoid glycosides contributing to anti-inflammatory, antiviral, and antioxidant properties. *G. Latifolium* however, recorded the lowest concentrations across most phytochemicals, corroborating earlier data by Atangwho *et al.*, (2013) indicating that *G. latifolium* contains lower phenolic density relative to other Nigerian medicinal vegetables. Despite this, *G. latifolium* remains a potent medicinal herb due to its strong alkaloid and glycoside profiles.

These variations suggest that bitter leaf may possess stronger antimicrobial and astringent properties, while papaya may demonstrate superior antioxidant and membrane-stabilizing activities. Differences in phytochemical density are also likely contributors to variations in anthelmintic responses across the extracts.

Acute toxicity assessment showed no mortality and no observable toxicity in rats administered up to 1000 mg/kg of all three extracts, indicating high safety margins for the plants. This aligns with OECD Guideline 423 and similar studies. The lack of behavioral disturbances—such as tremors, piloerection, salivation, or reduced locomotion—suggests that none of the extracts exert acute neurotoxic or hepatotoxic effects at therapeutic doses. Therefore, their use at 300 and 500 mg/kg in the subsequent anthelmintic evaluation is justified.

Post-mortem worm recovery showed marked reductions across all treatment groups compared to the negative control, with the highest activity observed in papaya 500 mg/kg (78.6%), followed by bitter leaf 500 mg/kg (75.1%) and utazi 500 mg/kg (70.8%). This indicates dose-dependent anthelmintic efficacy for all extracts.

The Faecal Egg Count (FEC) further confirmed the anthelmintic activity observed in worm burden outcomes. All extracts produced substantial reductions in egg output, with the greatest effect in papaya 500 mg/kg (86.4%), closely followed by bitter leaf 500 mg/kg (84.4%) and utazi 500 mg/kg (82.1%). These findings agree with the principle that egg count reduction correlates with inhibited worm fecundity, as described by Coles *et al.*, (1992). Papaya's strong effect may be attributed to papain's ability not only to kill worms but also to disrupt reproductive processes in remaining parasites. The moderate response at 300 mg/kg for all extracts (69–75%) illustrates partial suppression of worm fertility, supporting dose-dependency. Studies by Hounzangbé-Adoté *et al.*, (2005) and Bushel *et al.*, (2016) similarly reported that plant saponins, flavonoids, and terpenoids reduce worm egg output by impairing oogenesis and egg shell formation. That the negative control group showed increasing EPG values confirms disease progression and validates the therapeutic effects observed.

Body weight is a key indicator of general health, metabolic stability and the degree of physiological stress in laboratory animals. In the present study, helminth infection produced a marked negative effect on body-weight progression, as shown by the significant decline observed in the infected untreated control (IC) rats from day 3 through day 28. This pattern is consistent with the well-documented consequences of intestinal parasitism, which include anorexia, impaired nutrient absorption, mucosal damage, increased metabolic expenditure, and diversion of nutrients toward immune activation rather than growth (Okoye *et al.*, 2021). Treatment with ethanolic extracts of *Vernonia amygdalina* (BL), *Gongronema latifolium* (UZ) and *Carica papaya* (PAP) resulted in varying degrees of improvement in body-weight gain, with clear dose-dependent trends. Rats treated with BL 300 mg/kg and UZ 300 mg/kg exhibited modest recovery. Administration of BL 500 mg/kg and UZ 500 mg/kg produced markedly better weight gain, particularly in BL 500 mg/kg. *C. papaya* leaf extract produced the strongest restorative effects, particularly at 500 mg/kg. PAP 500 mg/kg not only reversed helminth-induced weight loss but produced the highest weight gain among all treatment groups.

Overall, the findings demonstrate that ethanolic extracts of *Carica papaya*, *Vernonia amygdalina* and *Gongronema latifolium* possess significant protective and restorative effects against helminth-induced physiological deterioration, with PAP 500 mg/kg showing the highest therapeutic potential.

Conclusion

This study investigated the phytochemical composition, acute toxicity, and anthelmintic efficacy of ethanolic extracts of *Vernonia amygdalina* (Bitter Leaf), *Gongronema latifolium* (Utazi), and *Carica papaya* (Pawpaw) in experimentally infected rats.

The extraction profile (Table 4.1) showed that *C.papaya* leaf produced the highest ethanol-soluble yield, followed by *V. amygdalina* and *G. latifolium* indicating greater phytochemical abundance. Qualitative and quantitative phytochemical analyses (Tables 4.2 and 4.3) confirmed the presence of key bioactive compounds such as flavonoids, saponins, phenols, alkaloids, and tannins, with *V. amygdalina* exhibiting the highest phenolic and tannin levels, while *C. papaya* possessed the highest flavonoid and saponin content. *G. latifolium* exhibited lower phytochemical concentrations.

The anthelmintic evaluation demonstrated clear therapeutic value. Worm burden and egg count results (Tables 4.5 and 4.6) showed significant dose-dependent reductions across all extracts. Among them, *C. papaya* 500 mg/kg exhibited the strongest anthelmintic activity, while *V. amygdalina* and *G. latifolium* also produced substantial reductions in worm load and fecal egg counts.

Overall, the findings provide compelling evidence that *C.papaya*, *V. amygdalina*, and *G. latifolium* extracts possess safe, potent, and mechanistically complementary anthelmintic properties.

Recommendations

Study should be extended to other helminth species to assess the broad-spectrum potential of the extracts.

Chronic toxicity and sub-chronic toxicity studies should be conducted to determine long term safety, organ-specific toxicity, and cumulative effects of the extracts.

Clinical trials in human populations should be carried out, especially in endemic communities to validate translational applicability.

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