

RESEARCH PAPER

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Gut health management of free-range Philippine native pigs (*Sus scrofa domestica* L.) with noni (*Morinda citrifolia* L.) fruit extracts**Karina Marie G. Nicolas****Department of Paraclinical Science, School of Veterinary Medicine, Isabela State University, San Fabian, Echague, Isabela, Philippines***Key words:** Anthelmintic, Gut health, Nematodes, Noni fruit, Philippine native pigs**Received:** June 26, 2026**Accepted:** July 06, 2026**Published:** July 13, 2026**DOI:** <https://dx.doi.org/10.12692/ijb/29.1.81-87>**ABSTRACT**

The study evaluated the effect of different preparations of NFE on the gut health of free-range Philippine native pigs (PhNP). Forty-eight (48) grower PhNP (3-4 mos old) were randomly placed in four treatments replicated thrice with four animals per replication following the CRD. Treatments include: Control (Levamisole); 20 ml aqueous NFE; 10mg/kg spray-dried NFE; and 30mg/kg spray-dried NFE). Noni-treated groups were administered per os once a day for 14 days. Necropsy was performed before and after 14 days of treatment. Data gathered were subjected to One-Way Analysis of Variance (ANOVA) and the Post-Hoc Tukey HSD Test to determine significant differences between treatments ($p \leq 0.05$). Paired T-test was used to compare the villous height and crypt depth before administration on the 14th day of the treatment. Phytochemical screening of the aqueous and spray-dried NFE revealed presence of phenols, flavonoids, glycosides, tannins and phytosterols. Fecalysis showed the presence of *Isospora* spp., *Oesophagostomum* spp., *Ascaris* spp., *Trichuris* spp., *Strongyloides* spp., and *Metastrongylus* spp. two of which reported to have a zoonotic potential. The NFE-treated groups recorded an FECR ranging from $88.19 \pm 0.28\%$ to $99.63 \pm 0.16\%$ which were statistically higher compared to levamisole at the 7th and 14th day of treatment and comparable with levamisole at the 14th day post-treatment. NFE-treated groups consistently showed an increase in efficiency up to the 21st day post-treatment. Gross and microscopic observations revealed improved integrity of intestinal mucosa with the absence of lesions post-treatment and significant improvement of villus height and crypt depth in the 30mg/kg spray-dried NFE.

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INTRODUCTION

The Philippine swine inventory as of January 2025 accounts to 8.74M heads (PSA, 2025) with swine population composed of several genetic groups like exotic standard purebreds, synthetic hybrids, Philippine wild pigs and the Philippine native pigs (PhNP) and its upgrades and crosses. The PhNP is an endemic genetic resource made up of multiple domesticated *Sus scrofa* lineages and interspecific hybrids (Banayo *et al.*, 2023) valuable in low-input production system. They are traditionally raised as a source of high-quality protein food, additional income and to support cultural, religious and other social activities of rural dwellers. Their ability to adapt to local environmental conditions and to utilize locally available feed materials enables them to survive and reproduce even with minimal intervention. The free-range farming system practiced in rearing native pigs, where animals have free access to soil, forages, and other risk factors make them susceptible to gastrointestinal parasitism.

Gastrointestinal parasites infecting pigs include *Balantidium coli*, *Iso spor a suis*, *Ascaris* spp., *Hyostrogylus* spp., *Metastrongylus* spp., *Macracanthorhynchus* *hirudinaceus*, *Oesophagostomum* spp., *Strongyloides* spp., *Taenia* spp., and *Trichuris* spp. (Ybañez *et al.*, 2017). These parasites cause inappetence, poor weight gain; poor feed conversion, and increased susceptibility to other pathogens, negatively affecting production performance, resulting to decrease income. The control of gastrointestinal parasites is dependent on the use of commercially prepared anthelmintics, which have limited accessibility to farmers in the barrios. Also, anthelmintic resistance is widespread in nematode parasites and has been detected in many species of animals. Filipinos are reported to have a per capita consumption of 14.90 kg for pork (Statista Research Department, 2021), and meeting the food needs of this growing and urbanizing population, along with health-conscious consumers who prefer food and products grown in a more natural way free of chemicals cannot be ignored. For these reasons, research on screening indigenous plants as anthelmintics remained a scientific interest to cater to these demands.

Morinda citrifolia commonly known as noni or “apatot” in Ilocano is a small evergreen tree which bears ovoid, “grenade-like” yellow fruits. It has been reported to contain scopoletin, octanoic, caprylic and linoleic acids, amino acids, acubin, L-asperuloside, potassium, vitamins A and C, terpenoids, alkaloids, anthraquinones, flavone glycosides, and proxeronine (Wang *et al.*, 2002). These phytochemicals contained in noni have been reported to have antibacterial, antiviral, anti-tubercular, antitumor, analgesic, and immunologic, hypotensive and anthelmintic activities.

The PhNP is a promising food resource and improving its health and production with ethnobotanical products like noni fruit can be an economical and healthier option for food security. This study determined the effects of the different noni fruit extract preparations against GIT parasites and their effects on the gross and microscopic appearance of the small and large intestines of free-range PhNPs.

MATERIALS AND METHODS

Noni fruit preparation

The noni fruit was authenticated by the National Museum, Botany Division, Padre Burgos Avenue, Rizal Park, Ermita, Manila. The aqueous extract was prepared using fresh ripe noni fruits washed thoroughly with water and drained. The fruits were chopped into fine pieces and placed in a blender to further macerate until it is juiced. The crushed fruit was soaked with distilled water in a ratio of 75:25 at ambient room temperature for 24 hours. The extract was drained through one layer of cheesecloth and pressed by hand until the extract was obtained. It was sieved through a piece of filter paper to remove the fine particles. The Spray Dried Noni Fruit powder was processed by Herbanext Laboratories Inc. using maltodextrin as excipient. Both extracts were phytochemically screened at Herbanext Laboratories Inc., Bago City, Negros Occidental.

Experimental animals, design and treatments

Forty-eight (48) three to four months old PhNP growers were used in the study. They were randomly

distributed following the Completely Randomized Design (CRD) to four treatment groups replicated thrice with four pigs per replication with the following treatments: T1- Levamisole (Latigo-500®) as per manufacturer's recommendation, T2- 20 mL aqueous extract, T3- 10 mg/kg spray dried noni fruit extract, and T4- 30 mg/kg spray dried noni fruit extract. The growers per replication were placed in a 100 m² range with an A-type shed. They were fed twice a day with commercial feed and forages with access to water *ad libitum*.

Test administration

The test extracts were administered once a day every day for two weeks before the growers was fed with their diet. Levamisole was prepared and administered following the manufacturer's recommendation.

Fecal examination

Fecal samples were collected directly from the rectum of the animals early in the morning before treatment administration and weekly thereafter. The samples were placed in collection caps with cover, labelled properly as to animal identification and date of collection. The samples were packed and placed in an ice box to prevent the eggs from developing and hatching. The identification of parasites was based on the structural morphology of the eggs/oocysts. Fecal egg counts (Egg per gram) were determined using the McMaster Technique with Sheather's floatation solution. Epg was recorded on the first and second weeks of treatment and for five consecutive weeks thereafter, while percent efficiency was determined using the FECR test following the formula:

$$\text{FECR \%} = ((\text{Pre-Treatment EPG} - \text{Post-Treatment EPG}) / \text{Pre-Treatment EPG}) \times 100$$

Gross and histological examination of the gastrointestinal tract

One grower pig from each replicate was randomly selected pre-treatment and on the 14th day of the treatment regimen. The animal was euthanized and necropsy was done to examine gross appearance of the small and large intestines. Two (2) centimeters of

the jejunal segments were collected, fixed in 10% neutral buffered formalin processed following the routine paraffin technique and stained with H and E stain. Villous height and crypt depth were measured on three (3) properly oriented villi and crypt depth to villus tip with mean readings recorded in micrometers.

Statistical analysis

Fecalysis data were subjected to one-way analysis of variance (ANOVA) using a Completely Randomized Design, with treatment as the fixed factor. When the overall F-test revealed a statistically significant treatment effect ($p < 0.05$), pairwise comparisons among treatment means were conducted using Tukey's Honest Significant Difference (HSD) post-hoc test to identify which specific treatment pairs differed significantly while controlling the family-wise error rate. Paired T-test was used to compare the villous height and crypt depth before and on the 14th day of the treatment using Stata v16.0.

RESULTS

Phytochemical screening of the aqueous and spray-dried noni fruit extract using qualitative test tube method revealed the presence of flavonoids, glycosides, phenols, phytosterols, steroids and tannins. Initial direct fecal smear revealed infection with *Isospora* spp., *Oesophagostomum* spp., *Ascaris* spp., *Strongyloides* spp. and *Trichuris* spp. Throughout the duration of the treatment period, no changes in the behavior as well as fecal consistency were observed. Also, no mortality was recorded which confirms the results of the prior toxicity trial conducted on ICR mice which reported safety of the test extracts even at 10,000mg/kg dose once a day for 14 days.

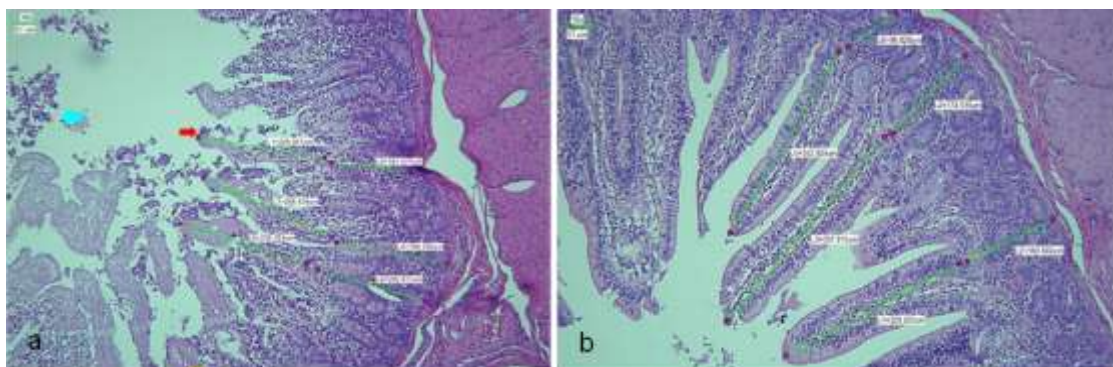
Table 1 shows the mean percentage efficiency of the Noni fruit extracts over the 7-week observation period, based on nematode epg counts. All treatment groups demonstrated progressive increases in percentage reduction (FECR) from seven (7) days of treatment until the 21st day post-treatment, ranging from 74.53± 2.83 to 99.63± 0.16.

Table 1. Percentage efficiency (FECR%±SD) against nematodes in native pigs of the noni fruit extracts (NFE) for the 7-week observation period

Treatments	During treatment				Post-treatment		
	7 th day	14 th day	7 th day	14 th day	21 st day	28 th day	35 th day
Levamisole	74.53± 2.83 ^a	97.09± 0.69 ^a	96.92± 2.74	99.39± 0.47 ^b	99.62± 0.39	99.51± 0.12	91.89± 4.51
20 mL aqueous NFE	88.19± 0.28 ^b	98.73± 0.44 ^b	98.8± 0.62	99.14± 0.18 ^b	99.49± 0.45	99.49± 0.15	97.13± 0.41
10 mg/kg spray-dried NFE	92.28± 2.99 ^{bc}	97.17± 0.93 ^{ab}	97.62± 2.17	96.06± 1.32 ^a	99.59± 0.23	98.64± 0.95	92.22± 3.06
30 mg/kg spray-dried NFE	96.34± 2.00 ^{cd}	98.19± 0.38 ^{ab}	99.52± 0.47	99.36± 0.44 ^b	99.63± 0.16	98.74± 1.39	93.58± 3.36

Table 2. Mean villous height and crypt depth (µm) of the jejunum before and 14 days of treatment

Treatments	Pre-treatment		14 Days of treatment		p-value
	Villous height	Crypt depth	Villous height	Crypt depth	
Levamisole	198.28	262.50	201.88	161.72	0.0076
20 mL aqueous NFE	243.94	204.71	277.83	227.41	0.7532
10 mg/kg spray-dried NFE	248.35	258.94	287.92	125.42	0.0663
30 mg/kg spray-dried NFE	228.06	216.12	342.22	243.66	0.0499

**Fig. 1a-b.** (a) Pre-treatment jejunal morphology: Sloughed off villous enterocytes (red arrow), villous blunting (yellow arrow) and sloughed off intestinal cells in the lumen of the jejunum (blue arrow), (b) Jejunal morphology of NFE treated pigs

Significant variations ($p \leq 0.05$) were noted at the 7th and 14th days of treatment, and 14 days post-treatment with the NFE-treated PhNP recording a higher percentage egg count reduction compared to Levamisole. The 30 mg/kg spray-dried NFE recorded the highest mean egg reduction at $96.34 \pm 2.00\%$ comparable and followed by the 10 mg/kg spray-dried NFE with $92.28 \pm 2.99\%$ and the 20 mL aqueous NFE with $88.19 \pm 0.28\%$ FECR at the 7th day of treatment. Percentage efficiency increased at the 14th day of treatment in all treatment groups ranging from $97.09 \pm 0.69\%$ to $98.73 \pm 0.44\%$ with the 30 mg/kg spray-dried NFE recording the highest reduction. Fourteen (14) days post-treatment, the 20 mL aqueous NFE and 30 mg/kg spray-dried NFE had a comparable result with the control (Levamisole). At the 28th day post-treatment, all the NFE-treated PhNP recorded a decrease in percentage efficiency similar to levamisole.

Gross appearance of the small and large intestinal mucosa revealed good muscle tone as exemplified by the folding back of the edges when cut longitudinally. All the segments of the small intestines examined from the different treatment groups before and 14 days of treatment showed intact mucosa with smooth, shiny pinkish surface. Pre-treatment examination of the small and large intestines, revealed that all the animals examined have nodular worms (*Oesophagostomum* spp.) present in the lumen while some were embedded in the mucosa of the large intestines. Intestinal mucosa had minimal pinpoint reddish to blackish indentations in the mucosa. However, these lesions have not been observed on the post-treatment examination.

Microscopic examination of the jejunal samples in almost all of the treatment groups revealed villous

blunting due to sloughed-off villous enterocytes, presence of sloughed intestinal cells in the lumen and adhesion of adjacent villi (Fig. 1a). Post-treatment microscopic evaluation of the jejunum, showed that the lining epithelium of the jejunum in Levamisole treated group has not yet thoroughly improved as compared to the noni treated groups wherein the villi have started to regain their height such that only the tips of the villi have unreplaced lining epithelium (Fig. 1b).

Shown in Table 2 are the pre- and post-treatment means of the villus height and crypt depth of the jejunum in the different treatment groups. Results reveal that generally, NFE-treated birds revealed a greater improvement in villous height as compared to Levamisole while the 10 mg/kg spray-dried NFE and Levamisole recorded a decrease in crypt depth after 14 days of administration. Results reveal a significant difference in the pre- and post-treatment villus height and crypt depth of Levamisole ($p=0.0076$) and the 30 mg/kg spray-dried NFE treated pigs ($p=0.0499$).

DISCUSSION

Phytochemical screening result agrees with the reports of Saminathan *et al.* (2013) and Pawlus *et al.*, (2005) although alkaloids were not tested in the fruit extracts in this study. The presence of the gastrointestinal parasites conforms to the reports of Manuel and Capuli, 1982; Padilla and Ducusin, 2017; Ybañez *et al.*, 2017) in small holder and commercial farms in the Philippines which affect different parts of the globe and pigs at various ages (Nsoso *et al.*, 2000). Infection with varied species of the gastrointestinal parasites observed in this study is similar to the reports on multiple infections with 2-5 parasites of Padilla and Ducusin (2017); Padilla and Ducusin (2015); and Ybañez *et al.* (2017). Also, two of the parasites found out in these studies which are *Ascaris* spp. and *Trichuris* spp. were reported to have zoonotic potential (Supan and Sanchez, 1994).

The occurrence of the gastrointestinal parasites in the native pig herd can be attributed with the range

management system in which they are raised. Some of the species observed in this study which includes *Ascaris* spp., *Oesophagostomum* spp., *Trichuris* spp., *Strongyloides* spp., and *Metastrongylus* spp. are reported in relation to outdoor-type of management (Nansen and Roepstorf, 1999). Their constant contact with the soil in the range and their rooting activities also increase the uptake of infective parasite eggs and larvae and intermediate hosts (IH) leading to their infection with the parasites (Obonyo *et al.*, 2013).

Also, the tropical climate in the country is ideal for the growth and multiplication of the parasites.

The increasing percentage of fecal egg count reduction observed in all treatment groups with NFE-treated birds recording a statistically higher percentage FECR during the treatment periods and comparable percentage FECR post-treatment means that the administration of the NFE causes continuous shedding of parasite eggs which may be due to apoptosis of the parasite or gastrointestinal epithelial cells and thereby interfering with the parasite development (Mittra *et al.*, 2000; Mamani and Matsuda *et al.*, 2004). The continuous egg shedding activity may lead to a time that no more eggs can be shed and thus the life cycle of the parasite is affected by reducing the number of possible parasites to mature. This explanation has been accounted by Tsinas *et al.* (1998) to the phenolic compounds which attack the upper layer of mature cells in the intestines so that sloughed-off debris may be composed of cells and eggs.

The post-treatment information on the gross morphology of the small and large intestines may be due to the claimed mode of action of levamisole which is paralysis of the adult worms while the interplay of the different phytochemical constituents present in the noni fruit extract caused the removal of the adult parasites and rapid regeneration of the intestinal mucosa. Absorption of nutrients primarily occur in the jejunum. Nutrient absorption is dependent on the integrity of the villi which are small finger-like projections in the intestinal mucosa.

The gross and histological findings are similar to the reports of Sunder *et al.* (2014) who claimed improved gut function of noni treated birds due to increased villous length and crypt depth of the intestines.

CONCLUSION

Phytochemical constituents such as flavonoids, glycosides, phenols, phytosterols, steroids, and tannins were found in the aqueous and spray-dried noni fruit extracts. Multiple gastrointestinal parasite infections were evident in free-range native pigs, and the administration of aqueous and spray-dried noni fruit extracts once daily for 14 days resulted in statistically higher and comparable reductions in fecal egg counts against nematodes compared with levamisole. Moreover, NFE improved the gross and microscopic morphology of the small intestines, resulting in improved gut health of Philippine native pigs.

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REFERENCES

- Banayo JB, Manese KV, Furusho KO, Salces AJ, Yamagata T.** 2023. Genetic diversity and population structure analysis of Philippine native pigs highlight five priority populations for conservation. *Ecology and Evolution* **13**, e10618.
DOI: 10.1002/ece3.10618
- Mamani-Matsuda M, Rambert J, Malvy D, Lejoly-Boisseau H, Daulouede S, Thiolat D, Coves S, Courtois P, Vincendeau P, Mossalayi MD.** 2004. Quercetin induces apoptosis of *Trypanosoma brucei gambiense* and decreases the proinflammatory response of human macrophages. *Antimicrobial Agents and Chemotherapy* **48**, 924–929.
- Manuel M, Capuli E.** 1982. Gastrointestinal helminths of swine in some selected commercial piggery farms in the Philippines. *Philippine Journal of Veterinary Medicine*.
- Mittra B, Saha A, Chowdhury AR, Pal C, Mandal S, Mukhopadhyay S, Bandyopadhyay S, Majumder HK.** 2000. Luteolin, an abundant dietary component, is a potent antileishmanial agent that acts by inducing topoisomerase II-mediated kinetoplast DNA cleavage leading to apoptosis. *Molecular Medicine* **6**, 527–541.
- Nansen P, Roepstorff A.** 1999. Parasitic helminths of the pig: Factors influencing transmission and infection levels. *International Journal of Parasitology* **29(6)**, 877–891.
- Nsoso S, Mosala K, Ndebele R, Ramabu S.** 2000. The prevalence of internal and external parasites in pigs of different ages and sexes in Southeast District, Botswana. *Onderstepoort Journal of Veterinary Research* **67(3)**, 217.
- Obonyo F, Maingi N, Githigia S, Ng'ang'a C.** 2013. Farming practices and risk factors for transmission of helminths of free-range pigs in Homabay District, Kenya. *Livestock Research for Rural Development* **25(36)**.
- Padilla M, Ducusin R.** 2015. Herd-level prevalence and factors for risk of endoparasite infection in smallholder pig farms in Sariaya, Quezon, Philippines. *Philippine Journal of Veterinary Medicine* **52(2)**.
- Padilla M, Ducusin R.** 2017. Prevalence of internal parasite infection in pigs and analysis of risk factors in smallholder pig farms in Cavite and Batangas, Philippines. *Philippine Journal of Veterinary Medicine* **51(1)**, 27–35.
- Pawlus AD, Su BN, Keller WJ, Kinghorn AD.** 2005. An anthraquinone with potent quinone reductase-inducing activity and other constituents of the fruits *Morinda citrifolia* (noni). *Journal of Natural Products* **68(12)**, 1720–1722.
- Philippine Statistics Authority.** 2025. Philippine Statistics Authority.
<https://psa.gov.ph>

Saminathan M, Rai RB, Ranganath G, Dhama K, Jhangir B. 2013. Evaluation of anticancerous activity of fruit juice of *Morinda citrifolia* in N-methyl-N-nitrosourea (NMU)-induced mammary tumors in rats. In: Proceedings of the 30th Annual Conference of the Indian Association of Veterinary Pathologists and National Symposium. November 21–23, 2013; Odisha, India. p. 49.

Statista Research Department. 2021. Per Capita Meat Consumption in the Philippines 2021. <https://www.statista.com/statistics/756518/philippines-meat-consumption-per-capita-by-type/>

Sunder J, Sujatha T, Pazhamvel N, Kundu A, Kundu M. 2014. Effect of *Morinda citrifolia* fruit juice and *Lactobacillus acidophilus* on broiler duodenal morphology. *Advances in Animal and Veterinary Sciences* **2**, 28–30.

Supan M, Sanchez G. 1994. External and internal parasites affecting animals in the different livestock projects of Pampanga Agricultural College (Magalang, Pampanga, Philippines). *PAC Research Journal*.

Tsinas G, Oskurt M, Aysult N, Seyrek K. 1998. Efficacy of in-feed preparations of an anticoccidial, multienzyme, prebiotic, probiotic, and herbal essential oil mixture in healthy and *Eimeria* spp.-infected broilers. *Poultry Science* **93**, 389–399.

Wang M, West BJ, Jensen CJ, Nowicki D, Su C, Palu AK, Anderson G. 2002. *Morinda citrifolia* (noni): A literature review and recent advances in noni research. *Acta Pharmacologica Sinica* **23(12)**, 1127–1141.

Ybañez RH, Bonghanoy J, Cinco F, Bance B, Toboso T, Artus K, Densing E, Ybañez AP. 2017. Detection of gastrointestinal parasites in commercial swine farms in Cebu, Philippines. *Journal of Agriculture and Technology Management* **20(1)**, 27–31.