



## Effect of *Heliotropium indicum* Leaf Powder Supplemented Diets on Growth Performance and Carcass Characteristics of Weaned Pigs

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Antibiotics, Growth, *Heliotropium indicum*, Phytocomponents, Performance.

### Abstract

A 60 day experiment was carried out at Sumitra Research Institute, Gujarat, India to examine the effect of *Heliotropium indicum* leaf powder supplemented diets on growth performance and carcass characteristics of weaned pigs. A total of 50 crossbred male pigs (Landrace × Duroc) with initial body weight of  $9.06 \pm 0.44$  kg weaned at 30 days of age were randomly divided into five treatments with six replicates (1 pig per replicate) and fed three experimental diets. Treatment 1; corn-soybeal meal (regular diet) without *Heliotropium indicum* leaf powder (control), treatment 2: regular diet with 0.50 g neomycin/kg diet while treatment 3, 4 and 5 received regular diet supplemented with *Heliotropium indicum* leaf powder at 100 g, 200g and 300 g per kg diet. A completely design was adopted and animals had unrestricted access to clean water and feed. Experimental results revealed that average daily body weight and average daily feed consumption varied from 0.14 to 0.26 kg and 0.71 to 0.82 kg respectively were higher among pigs in treatment 3, 4 and 5, intermediate in treatment 2 and lower in treatment 1 ( $p < 0.05$ ). Increasing the dietary supplementation of *Heliotropium indicum* leaf powder decreased the feed to gain ratio from 5.25 to 3.15 ( $p < 0.05$ ). Dressing percentage and weights of hind limbs, fore limbs, head, back, belly, heart, lungs and kidney were significantly ( $p < 0.05$ ) influenced except for the spleen ( $p > 0.05$ ). It was concluded that supplementing *Heliotropium indicum* leaf powder up to 300 g/kg in the diet of weaned pigs influenced their growth and pose no negative effect on the health status of animals.



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### INTRODUCTION

Global concern over potential antibiotic resistance risks related to human health has driven interest in pig nutrition over the adoption of antibiotic free feeding systems (Caroline, 2022). Despite these debates on the role of antibiotics use in conferring antimicrobial resistance to human pathogens, many countries in Europe have issued a ban on the approval for antibiotics as growth promoters since January 2006 on precautionary grounds (Chen, 2015; Woodward, 2020). Currently, there is an increasing interest to find alternative substances and strategies to improve the health status of farm animals for human consumption and the use of medicinal plant is considered as one of

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the potential alternative with no withdrawal period, no drug resistance, no environmental pollution and no toxic residue in final products (Alagbe, 2024).

*Heliotropium indicum* is one of the underutilized perennial medicinal plant belonging to the family Boraginaceae and order Boraginales consisting of over 200 species distributed globally (Owolabi, Oribayo, Ukpo, Mbakab, & Akindehin, 2015; Roy, 2015). The plant is found in many countries including, India, Pakistan, Bangladesh, Philippines, Nigeria, Kenya, Zambia, South Africa amongst others (Boye, Koffuor, Amoateng, Ameyaw, & Abaitey, 2012; Kumar & Kumar, 2016). *Heliotropium indicum* can reach up to about 50 cm in height and its leaves are opposite or sub-opposite, alternate or sub-alternate and straight forward, sheet-shaped from ovate to elliptical, hairy, and sharp and 5 to 10 cm long in length. In traditional system of medicine, the aqueous leaf extract and stem bark of *Heliotropium indicum* are used for the treatment of fever, stomach ache, arthritis, malaria, diarrhea, snake bite, kidney disease, sexually transmitted disease, urinary disease, cough, asthma, high blood pressure, epilepsy, convulsion, dysentery, cancer and general body pain (Ghosh, Das, Das, Mahapatra, & Chatterjee, 2018; Suroowan, Pynee, & Mahomoodally, 2019).

Several phytochemicals or bioactive compounds have been identified in the plant including, tannins, triterpenoids, alkaloids, (example: heleurine N-oxide, cynoglossine, retronecine, helindicine and indicine, indicinine), saponins, steroids, flavonoids, triterpenoids, volatile oils amongst others (Odugbemi, Akinsulire, Aibinu, & Fabeku, 2007). The presence of these compounds makes the plant act as antimicrobial, antioxidant (Dash & Murthy, 2011), anti-inflammatory, cytotoxic (Veda et al., 2016), antibacterial, anti-helminthic, anticancer (Reddy, 2015), anti-diabetic, immune stimulator (Boye et al., 2012), digestive stimulator, antinociceptive (Chunthornng-Orn et al., 2016), analgesic, anti-hyperglycemic, anti-cataract (Abdel-Sattar et al., 2009), anti-plasmodial, antitussive (Odugbemi et al., 2007), antitumor, anti-allergic, larvicidal and pesticidal properties.

Previous studies have shown that supplementation of herbs or medicinal plants in the diet of animals could enhance the activities of endogenous enzymes in the gastrointestinal tract, thereby promoting absorption of nutrients and efficiency of feed utilization (Bhatt, 2015). However, outcome from most of these studies have not been consistent, these discrepancies could be influenced by several factors such as, levels of supplementation (Anorue, Ubong, & John, 2023), processing method, composition of phyto-components amongst others. For instance, a study carried out by (Albarka, 2023), revealed that dietary supplementation of *Heliotropium indicum* leaf powder up to 80 g/kg in the diet of weaned pigs did not influence their growth performance. There is need to establish an optimum level and also provide scientific basis for the use of *Heliotropium indicum* leaf powder in animals feed. This research will not only address the increasing rate of antimicrobial resistance, it will also promote food safety and environmental sustainability.

Therefore this study was designed to evaluate the effect of *Heliotropium indicum* leaf powder supplemented diets on growth performance and carcass characteristics of weaned pigs.

## **METHOD**

### **Experimental location, duration, collection and preparation of *Heliotropium indicum* leaf powder**

Sumitra Research Institute's Piggery unit in Gujarat, India was used for the experiment and animals were cared for following the guidelines and management procedures approved by Animal Production department of Sumitra Research Institute, Gujarat. The whole experimental period is eight weeks.

*Heliotropium indicum* leaves were collected within the premises of Sumitra Research Institute, Gujarat, India before it was sent to the institute's taxonomy department for proper identification and a registration number GH/008/2023 was assigned after authentication. Collected leaves were shade dried for 13 days until the leaves turns pale brown and a constant weight was

achieved before it was grounded into powder using an electric blender. The powdered leaf was collected into a labeled air tight plastic bucket before it was taken to the laboratory for further evaluation.

**Management of experimental animals, diet and design**

A total of 50 crossbred male pigs (Landrace × Duroc) with initial body weight of  $9.06 \pm 0.44$  kg weaned at 30 days of age were randomly divided into five treatments with six replicates (1 pig per replicate) and fed three experimental diets. The feed used for this experiment was corn-soy bean meal based diet which was consistent with the National Research Council’s requirement for growing pigs (NRC, 2012) as presented in Table 1.

**Table 1.** Composition and Nutrient Levels of Experimental Diets

Ingredients	Inclusion (%)
Maize	50.00
Rice bran	5.50
Soy bean meal	33.00
Oyster shell	3.00
Bone meal	6.00
HL-Lysine	0.25
DL-Methionine	0.25
*Growers premix®	0.25
TNRoxin binder®	0.02
Sodium chloride	0.30
Total	100.0
Determined analysis (expressed in %)	
Crude protein	23.18
Crude fibre	5.05
Ether extract	3.98
Ash	3.62
Metabolizable energy (Kcal/kg)	2800.6

Treatment 1; corn-soybean meal (regular diet) without *Heliotropium indicum* leaf powder (control), treatment 2: regular diet with 0.50 g neomycin/kg diet while treatment 3, 4 and 5 received regular diet supplemented with *Heliotropium indicum* leaf powder at 100 g, 200g and 300 g per kg diet. The dietary treatment began on day eight after one week adjustment period and pigs were fed thrice daily (6:30, 12:00 and 15:00 H). They also had unrestricted access to clean fresh water and a completely randomized design model was adopted. Average initial body weight was taken immediately upon the arrival of pigs using a digital scale and thereafter on a weekly basis. Average body weight gain, daily weight gain, average total feed consumption and daily feed consumption were all calculated. Average body weight gain (expressed in kg) = Average final body weight minus average initial body weight.

Daily weight gain (in kg) = Average final body weight minus average initial body weight divided by the experimental period in days.

Total feed consumption = Left over minus feed served (expressed in kg)

Daily feed consumption (kg) = Left over minus feed served divided by the experimental period in days.

### Carcass characteristics evaluation

At the end of the experiment five pigs were selected per treatment and their average body weight was measured. Pigs were feed starved for 12 hours and given access to water before they were stunned, bled and their hair was removed after using sharp kitchen knife, eviscerated and cut into different parts. Weights of head, belly, fore limb, hind limb, back and those of organs (heart, lungs, kidney and spleen) were measured. Dressing percentage was estimated using the following formula:

$$\text{Dressing \%} = \text{Carcass weight divided by Live weight multiplied by 100.}$$

### Phytochemicals in *Heliotropium indicum* leaf powder

Portable Griffin™ G510 gas chromatograph mass spectrometer was used to evaluate the various phytochemicals in *Heliotropium indicum* leaf powder. Quantification of various compounds was carried out at different optical densities. For tannins, saponins, alkaloids, flavonoids, steroids, glycosides, triterpenoids and anthraquinones at 310 nm, 450 nm, 280 nm, 520 nm, 660 nm, 360 nm, 570 nm and 640 nm respectively.

### Proximate determination of experimental diet

Determination of proximate components was carried out using Perkin Elmer benchtop near infra-red analyzer (Netherlands). Kit was adjusted at an optical bandwidth, spectral resolution, wavelength range, and wavelength precision of 10.44 nm, 0.5 nm/data point, 1700 nm and 0.5 nm respectively according to the manufacturers' recommendation.

### Statistical analysis

Data obtained on growth performance and carcass characteristics was subjected to one -way analysis of variance using Statistical Package for Social Sciences (version 25). Significant differences among the treatments were subjected to comparisons using the Duncan multiple range test of the same software. All differences were considered to be statistically significant when  $p < 0.05$ .

## RESULT AND DISCUSSION

Composition and nutrient levels of experimental diets is presented in Table 1. The diet contains crude protein (23.18 %), crude fibre (5.05 %), ether extract (3.98 %), ash (3.62 %) and energy (2800.6 Kcal/kg).

**Table 2.** Phytochemicals in *Heliotropium indicum* leaf powder

Phytochemicals	Composition (expressed in mg/g)
Tannins	196.7
Alkaloids	102.6
Saponins	85.31
Flavonoids	609.7
Steroids	90.50
Glycosides	25.11
Anthraquinones	30.65
Triterpenoids	258.9

As presented in Table 2, phytochemicals in *Heliotropium indicum* leaf powder. Result revealed the presence of flavonoids (609.7 mg/g), triterpenoids (258.9 mg/g), tannins (196.7 mg/g), alkaloids (102.6 mg/g), steroids (90.50 mg/g), saponins (85.31 mg/g), anthraquinones (30.65 mg/g) and glycosides (25.11 mg/g) in their order of abundance.

**Table 3.** Growth Performance

Parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	SEM
Initial body weight (kg)	9.09	9.08	9.06	9.07	9.06	
Final body weight (kg)	17.21 <sup>c</sup>	19.58 <sup>b</sup>	24.10 <sup>a</sup>	24.45 <sup>a</sup>	24.67 <sup>a</sup>	
Average body weight gain (kg)	8.12 <sup>c</sup>	10.50 <sup>b</sup>	15.04 <sup>a</sup>	15.38 <sup>a</sup>	15.61 <sup>a</sup>	
Average daily weight gain (kg)	0.14 <sup>c</sup>	0.18 <sup>b</sup>	0.25 <sup>a</sup>	0.26 <sup>a</sup>	0.26 <sup>a</sup>	
Average feed consumption (kg)	42.65 <sup>c</sup>	44.32 <sup>b</sup>	49.33 <sup>a</sup>	49.04 <sup>a</sup>	49.22 <sup>a</sup>	
Average daily consumption (kg)	0.71 <sup>c</sup>	0.74 <sup>b</sup>	0.82 <sup>a</sup>	0.82 <sup>a</sup>	0.82 <sup>a</sup>	
Feed: gain ratio	5.25 <sup>a</sup>	4.22 <sup>b</sup>	3.27 <sup>c</sup>	3.18 <sup>c</sup>	3.15 <sup>c</sup>	

Values followed by different letters were significantly different ( $p < 0.05$ ); treatment 1: basal/regular diet without *Heliotropium indicum* leaf powder (control); treatment 2 (Neomycin 0.25 g/kg diet), treatment 3, 4 and 5: basal diet supplemented with *Heliotropium indicum* leaf powder at 100 g, 200 g, and 300 g per kg respectively; SEM: standard error of mean.

As displayed in Table 3, growth performance of weaned rabbits fed with *Heliotropium indicum* leaf powder. Average daily weight gain and average daily feed consumption of pigs fed treatment 3 (100 g *Heliotropium indicum* leaf powder/kg diet), treatment 4 (200 g *Heliotropium indicum* leaf powder/kg diet) and treatment 5 (300 g *Heliotropium indicum* leaf powder/kg diet) were similar ( $p > 0.05$ ) but significantly higher ( $p < 0.05$ ) than those which received treatment 2 (0.25 g neomycin/kg diet) and treatment 1 (without *Heliotropium indicum* leaf powder/kg diet). Increase in the dietary supplementation of *Heliotropium indicum* leaf powder significantly decreased ( $p < 0.05$ ) feed to gain ratio of pigs compared with treatment 2 and treatment 1.

**Table 4.** Carcass Characteristics

Variables (kg)	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	SEM
Live weight (kg)	18.06 <sup>c</sup>	20.76 <sup>b</sup>	25.87 <sup>a</sup>	25.90 <sup>a</sup>	25.98 <sup>a</sup>	
Carcass weight	11.31 <sup>c</sup>	13.87 <sup>b</sup>	19.10 <sup>a</sup>	19.15 <sup>a</sup>	19.21 <sup>a</sup>	
Dressing percentage	62.62 <sup>c</sup>	66.81 <sup>b</sup>	73.83 <sup>a</sup>	73.93 <sup>a</sup>	73.94 <sup>a</sup>	
Head	2.41 <sup>b</sup>	2.67 <sup>b</sup>	3.39 <sup>a</sup>	3.42 <sup>a</sup>	3.48 <sup>a</sup>	
Back	3.04 <sup>b</sup>	3.56 <sup>b</sup>	4.04 <sup>a</sup>	4.11 <sup>a</sup>	4.15 <sup>a</sup>	
Hind limb	4.02 <sup>b</sup>	4.56 <sup>b</sup>	5.00 <sup>a</sup>	5.02 <sup>a</sup>	5.05 <sup>a</sup>	
Fore limb	3.97 <sup>b</sup>	4.43 <sup>b</sup>	5.06 <sup>a</sup>	5.18 <sup>a</sup>	5.26 <sup>a</sup>	
Belly	2.11 <sup>b</sup>	2.53 <sup>b</sup>	3.07 <sup>a</sup>	3.18 <sup>a</sup>	3.22 <sup>a</sup>	
Kidney	0.03 <sup>c</sup>	0.12 <sup>b</sup>	0.19 <sup>a</sup>	0.20 <sup>a</sup>	0.21 <sup>a</sup>	
Lungs	0.18 <sup>b</sup>	0.20 <sup>b</sup>	0.37 <sup>a</sup>	0.40 <sup>a</sup>	0.41 <sup>a</sup>	
Spleen	0.03	0.04	0.04	0.04	0.04	

Heart	0.16 <sup>c</sup>	0.25 <sup>b</sup>	0.42 <sup>a</sup>	0.48 <sup>a</sup>	0.49 <sup>a</sup>
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Values followed by different letters were significantly different ( $p < 0.05$ ); treatment 1: basal/regular diet without *Heliotropium indicum* leaf powder (control); treatment 2 (Neomycin 0.25 g/kg diet), treatment 3, 4 and 5: basal diet supplemented with *Heliotropium indicum* leaf powder at 100 g, 200 g, and 300 g per kg respectively; SEM: standard error of mean.

Carcass characteristics of weaned rabbits fed with *Heliotropium indicum* leaf powder. Carcass and dressing percentage follow similar trend as *Heliotropium indicum* leaf powder increased these parameters compared to the other groups. Dressing percentage values were lowest in treatment 1, intermediate in treatment 2 and highest in treatment 3, 4 and 5 ( $p < 0.05$ ). Weights of head, back, fore limb, hind limbs, belly, kidney, lungs and heart were highest in treatments supplemented with *Heliotropium indicum* leaf powder (treatment 3, 4 and 5), intermediate in treatment 2 and lower in treatment 1 except for those values recorded for spleen which was not influenced ( $p > 0.05$ ) by the treatment.

## Discussion

The outcome on average daily body weight showed that pigs which received *Heliotropium indicum* leaf powder had higher values compared to the other group. This suggests that the presence of phytochemicals in *Heliotropium indicum* leaf powder could stimulate or enhance digestive enzyme activities and absorption of nutrients leading to a better nutrient utilization which in turn translates to a higher weight gain in pigs (Alagbe, 2024). Though there was similarity in average weight gain among pigs fed diet supplemented with *Heliotropium indicum* leaf powder (treatment 3, 4 and 5) followed by those which received neomycin (treatment 2) and lowest in treatment 1 suggesting that neomycin was also an effective synthetic growth promoter. Previous reports by shown that phytochemicals in medicinal plants possess vital nutritional and medicinal properties (Ojediran, Alagbe, Victor, & Adewale, 2024; Singh, Datta, Johri, & Trivedi, 2022). The presence of flavonoids, tannins, alkaloids, saponins, triterpenoids, steroids, anthraquinones and glycosides in *Heliotropium indicum* leaf powder indicates multiple pharmacological functions such as, anti-inflammatory, antioxidant, antiviral, antifungal, immune-stimulators (Adewale, Alagbe, & Adeoye, 2021), gastro-protective, anticancer, anti-diabetic, antimicrobial (Daniel et al., 2023), anti-helminthic, antidiarrheal, antibacterial amongst others. Result on average weight gain was similar to the earlier report by (). Conversely, (John, 2024) found out supplementation of *Heliotropium indicum* leaf powder at 30 g/kg diet did not influence daily body weight of growing pigs. The discrepancies in results could be attributed to levels of supplementation, nature of bioactive compounds in the test material as well as method of preparation (Adewale et al., 2021). Increase in daily feed consumption especially among pigs fed with *Heliotropium indicum* leaf powder aligns with the notion that dietary supplementation of medicinal plants can improve palatability of diet thereby facilitating taste receptors in pigs. This result conforms to the earlier report by (Omokore & Alagbe, 2019) when phytochemicals was fed to growing rabbits. Feed to gain ratio which varied from 3.15 to 5.25 decreased as the level of *Heliotropium indicum* leaf powder increased in the diet of pigs suggesting efficiency in feed utilization in the treatment. This further reaffirms that phytochemicals in *Heliotropium indicum* leaf powder have the capability to stabilize gut against proliferation by pathogenic organisms. Result obtained is in agreement with the reports by (Santi D Upadhaya, Lee, & Kim, 2016; Santi Devi Upadhaya, Kim, & Kim, 2016) who discovered that growing pigs fed blend of phytochemicals had a feed to gain ratio of 3.23 - 5.50.

Dressing percentage are useful indices to determine meat yield in animals. Findings of this present study (62.62 to 73.94 %) was similar to the result of a study by (Zhou, Zhang, & Kim, 2013)

who showed that dressing percentage of growing pigs fed *Coptis chinensis* herb extract varied from 61.94 to 74.05 % as well as those reported by (Yan, Zhang, Park, & Kim, 2012) who discovered that dressing percentage of weanling pigs fed diet supplemented with *Houttuynia cordata* and *Taraxacum officinale* varied from 60.09 to 73.00 %. The present experiment revealed that weights of back, belly, fore limb, hind limb, kidney, lungs and heart was influenced by *Heliotropium indicum* leaf powder in the diet which was a result of the increase in dressing percentage. This result suggests that *Heliotropium indicum* leaf powder is non-toxic and can modulate the retention time of feed in the gastro intestinal tract of pigs (Shittu, Alagbe, Ojebiyi, Ojediran, & Rafiu, 2022). (Ao, Lei, & Kim, 2019; Jeong & Kim, 2015; Lei, Yun, & Kim, 2018), discovered that weights of head, back, fore limb and hind limb varied from 2.00 - 3.80 kg, 3.00 - 5.00 kg, 3.80 - 5.50 kg and 3.90 - 5.70 kg respectively in growing pigs fed diet supplemented with natural and fermented herbs. The higher values recorded in heart and lungs of pigs fed *Heliotropium indicum* leaf powder compared to the other group suggests sufficient supply of oxygen in the system of pigs (Olafadehan, Oluwafemi, & Alagbe, 2020). The kidney plays a key role in the waste removal as well as extra water to make urine. Supplementation of *Heliotropium indicum* leaf powder did not influence weight of spleen suggesting that the integrity of the immune system was not compromised (Anorue et al., 2023). *Heliotropium indicum* leaf powder is known to contain flavonoids which possess antioxidant properties and scavenging the activities of free radicals.

## CONCLUSION

It was concluded that *Heliotropium indicum* leaf powder has both nutritional and medicinal properties. It also contains compounds that has no toxic side effects. Results on growth revealed that supplementing *Heliotropium indicum* leaf powder up to 300 g/kg had no deleterious effect on the growth performance as well as organs in the animal's body. The supplementation of *Heliotropium indicum* leaf powder can also help to address multidrug resistance and promote food safety.

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