

## *Cordyline fruticosa* leaf powder supplemented in the diet of weaned pigs: effect on growth performance, hematological and serum biochemical indices

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### Abstract

In Sumitra Research Institute, Gujarat, a total of 50 cross-bred male piglets (Yorkshire × Landrace) with an initial body weight of  $9.77 \pm 0.06$  kg weaned at 28 days were randomly distributed 5 treatments of 10 replicates containing 1 animal each in 60 days' trial. According to the Nutritional Research Council's recommendation in 2012, a basal diet was adequate in all nutrients. Pigs in treatment 1 were fed a basal diet without *C. fruticosa* leaf powder while treatments 2, 3, 4, and 5 were fed the same diet supplemented with *C. fruticosa* leaf powder at 20 g, 40 g, 60 g, and 80 g respectively. Animals were given unrestricted access to fresh clean water and a completely randomized design was adopted. The experimental result showed that average daily weight gains and average daily feed intake which took the form of 0.29-0.46 kg and 0.68-0.77 kg were higher in the *C. fruticosa* leaf powder-supplemented group relative to the control ( $p < 0.05$ ). The treatments significantly influenced the best feed conversion ratio and mortality rate from 1.73-2.34 to 1.0-3.0% ( $p < 0.05$ ). Haemoglobin, red blood cell, pack cell volume, total platelet count, mean platelet volume, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, white blood cell, lymphocytes, and monocytes count follow a similar trend as values were greater in treatment 3, 4 and 5, an intermediary in treatment 2 and lower in treatment 1 ( $p < 0.05$ ). The treatment significantly influenced total protein, glucose, cholesterol, Calcium, and Phosphorus values ( $p < 0.05$ ). In contrast, bilirubin, urea, creatinine, sodium, chloride, alanine transaminase, aspartate aminotransferase, and alkaline phosphatase values were similar among the treatments ( $p > 0.05$ ). In conclusion, *Cordyline fruticosa* leaf powder can be supplemented in the diet of weaned pigs without causing any negative effect on the growth and health status of weaned pigs.

**Keywords:** *Cordyline fruticosa* leaf, phytochemicals, pharmacological, food safety, medicinal plant.

## Folha de *Cordyline fruticosa* em pó suplementada na dieta de leitões desmamados: efeito no desempenho zootécnico, índices hematológicos e bioquímicos séricos

### Resumo

No Sumitra Research Institute, Gujarat, um total de 50 leitões machos mestiços (Yorkshire × Landrace) com peso corporal inicial de  $9,77 \pm 0,06$  kg desmamados aos 28 dias foram distribuídos aleatoriamente em 5 tratamentos de 10 repetições contendo 1 animal cada em 60 dias julgamento. A dieta basal foi adequada em todos os nutrientes de acordo com a recomendação do Conselho de Pesquisa Nutricional em 2012. Os porcos do tratamento 1 foram alimentados com uma dieta basal sem pó de folhas de *C. fruticosa*, enquanto os tratamentos 2, 3, 4 e 5 foram alimentados com a mesma dieta suplementada com folha de *C. fruticosa* em pó em 20 g, 40 g, 60 g e 80 g, respectivamente. Os animais tiveram acesso irrestrito a água limpa e fresca e um desenho completamente casualizado foi adotado. O resultado experimental mostrou que o ganho médio diário de peso e o consumo médio diário de ração, que assumiram a forma de 0,29-0,46 e 0,68-0,77 kg, foram maiores no grupo suplementado com pó de folhas de *C. fruticosa* em relação ao controle ( $p < 0,05$ ). A melhor conversão alimentar e taxa de mortalidade variaram de 1,73-2,34, 1,0-3,0% foram influenciadas significativamente ( $p < 0,05$ ) pelos

tratamentos. Hemoglobina, glóbulos vermelhos, volume celular, contagem total de plaquetas, volume médio de plaquetas, volume corpuscular médio, hemoglobina corpuscular média, concentração média de hemoglobina corpuscular, contagem de glóbulos brancos, linfócitos e monócitos seguem uma tendência semelhante, pois os valores foram maiores no tratamento 3, 4 e 5, intermediário no tratamento 2 e inferior no tratamento 1 ( $p < 0,05$ ). Os valores de proteína total, glicose, colesterol, Cálcio e Fósforo foram significativamente ( $p < 0,05$ ) influenciados pelo tratamento. Em contrapartida, os valores de bilirrubina, uréia, creatinina, Sódio, cloreto, alanina transaminase, aspartato aminotransferase e fosfatase alcalina foram semelhantes entre os tratamentos ( $p > 0,05$ ). Em conclusão, o pó da folha de *Cordyline fruticosa* pode ser complementado na dieta de leitões desmamados sem causar qualquer efeito negativo no crescimento e no estado de saúde dos leitões desmamados.

**Palavras-chave:** folha de *Cordyline fruticosa*, fitoquímicos, farmacológicos, segurança alimentar, planta medicinal.

## 1. Introduction

Growing antibiotic resistance is leading to a continuous need to discover new drugs and alternative treatments against infections (Vera, 2021). In 2009, the World Health Organization named antimicrobial resistance as one of the three greatest threats to human health. This challenge prompted the European Union in the same year to place a ban on the use of antibiotic growth promoters in animal feed. Therefore, the use of herbal plants was proposed as one of the potential alternatives to antibiotics because they contain no-toxic chemicals, pose no pollution to the environment, without a withdrawal period, and have lower side effects compared to synthetic drugs (Adewale et al., 2021; Daniel et al., 2024).

The herbal plant contains phytoconstituents with numerous pharmacological activities (Singh et al., 2022). Active substances contained in plants and their extracts belong to the plant secondary metabolites group and may inhibit many different biological properties in animals (Alagbe, 2023). These active compounds can be found in the leaves, stem bark, flowers, buds, and roots of plants at various concentrations (Alagbe, 2023). The age of the plant, species, method of processing, and geographical location amongst others could influence the concentrations of phyto-constituents in herbal plants (Ojediran et al., 2024). Among the potential herbal, underexplored plants is *Cordyline fruticosa*.

*Cordyline fruticosa* belongs to the family Agavaceae. It is commonly known as dehuang, *Cordyline* genus comprises over 300 species spread in tropical and subtropical regions throughout the world (Nguyen et al., 2021; Alagbe, 2024; John, 2024). The plant is a perennial evergreen, shrub that grows up to 3 meters in height. Leaves show diverse colours and are spirally arranged into a fan-like shape at the stem tips (Hemaiswarya et al., 2009; Fouedjou et al., 2014). Traditionally, the aqueous extract from *Cordyline fruticosa* leaves can be used for the treatment of gastrointestinal disease, arthritis, digestive disorders, malaria, cough, respiratory disease, liver infections, diarrhea, and skin disease (Elfita et al., 2019; Akram et al., 2020).

The root extracts also showed significant cure against gastrointestinal disorders (Shihabudeen et al., 2010). Phytochemical evaluation of *C. fruticosa* leaves reveals the presence of tannins, alkaloids, steroids, terpenoids, phenols, and flavonoids (Fuedjaou et al., 2016; Alagbe, 2023). These compounds exhibit notable antioxidant, antipyretic, cytotoxic, immuno-modulatory, hepato-protective, antimicrobial, antifungal, anti-tumor, anxiolytic, analgesics, antiviral, hypoglycemic, anti-inflammatory properties amongst others (Wijaya et al., 2015; Mahayani et al., 2019).

Several field studies have shown a positive outcome when medicinal plants or phytogenics were supplemented in the diet of pigs. For instance, Ahmed et al. (2013) reported an improved protein digestibility and weight gain in weaned pigs fed oregano extract at 0.125 percent. Yan & Kim (2012) also observed a reduction in fecal *Escherichia coli* count and an increase in the *Lactobacillus* spp population of pigs fed diet supplemented with eugenol at 250 mg/kg<sup>-1</sup> diet. Reports from Czech et al. (2009) showed that pigs fed herbal extract at 0.8 g/kg<sup>-1</sup> diet showed an increase in average daily weight gain as well as their feed intake. However, there is little or no report on the dietary supplementation of *C. fruticosa* leaves in the diet of weaned pigs. This experiment is timely because it will give a clue on the appropriate dose required by the animal and will also address the increasing cases of antimicrobial resistance, promote food safety and sustainability.

This study aims to examine the impact of dietary supplementation of *Cordyline fruticosa* leaves on the growth performance and hemato-biochemical indices of weaned pigs.

## 2. Materials and Methods

### 2.1 Experimental location, ethical approval, and processing of test material

The experiment was carried out at the Livestock Unit, Sumitra Research Institute, Gujarat, India in January to March 2022. The institute is located between 23° 13' N and 72° 41' E. The trial was carried out in accordance with the guidelines that had been authorized by the ethics council of Sumitra Research Institute, India (VN/114/2022).

Mature *Cordyline fruticosa* leaves were harvested at the crop protection department of the institute and taken to the Biological Science section for proper identification by a certified taxonomist (PhD. Vinod Amit) where a voucher number TD/008F was assigned to the leaf. Thereafter, collected leaves were air dried under shade for 16 days until a constant weight was obtained. Dried leaves were ground in an electric blender to obtain *C. fruticosa* leaf powder and stored in a labeled polythene bag for further examination.

### 2.2 Management of experimental animal and design

In Sumitra Research Institute, Gujarat, a total of 50 cross-bred male piglets (Yorkshire × Landrace) with an initial body weight of  $9.77 \pm 0.06$  kg weaned at 28 days were housed individually in an automated pen measuring 3.0 m by 1.5 meters by 1.0 meters (length × width × height) and equipped with aluminum automatic feeders and drinkers. Before the commencement of the trial, pigs were given Fenbendazole<sup>®</sup> against parasites and allotted into 5 treatments of 10 replicates of 1 animal each. The basal diet (Corn-Soya base diet) was adequate in all nutrients according to the recommendations of the Nutritional Research Council in 1994.

Piglets in treatment one were fed a basal diet without therapeutic levels of *C. fruticosa* powder while treatments two, three, four, and five were fed the same diet supplemented (Table 1) with *C. fruticosa* powder at 20 g, 40 g, 60 g, and 80 g respectively. Proper biosecurity measures were put in place and animals were fed *trice* daily (7:00, 12:00, and 17:00 h). Animals had unrestricted access to fresh clean water. A completely randomized design was adopted, and all necessary management practices were strictly adhered to throughout the 60-day experimental period. Feed consumed was calculated by subtracting the leftover from what was served to the animals (expressed in kilogram (kg));

Average daily feed intake = Total feed intake divided by the duration of the experiment in days (60 days)

Average daily weight gain = Total weight gain divided by the duration of the experiment in days (60 days)

Feed conversion ratio = Total feed divided by the weight gain

### 2.3 Proximate analysis of experimental diet

Analysis of the experimental diet was carried out using Foss near infra-red automated feed analyzer NIRSTM DS2600 with reflectance or transmittance. 200 g of experimental diet was transferred into the collection funnel and the kit was adjusted to a wavelength range of 400-2500 nm, optical bandwidth ( $8.75 \pm 0.1$  nm), spectral resolution (0.5 nm), wavelength accuracy ( $< 0.05$  nm) and absorbance range up to 2 AU before generating results via the monitor in less than 60 s.

### 2.4 Blood examination

At the end of the 60th day, blood samples were collected from the culinary vein of 5 randomly selected pigs per treatment. An ice pack from Sumitra Research Laboratory, Gujarat was taken to the field to preserve blood samples. 4 mL of blood was collected from each animal and divided into two. 2 mL for haematological analysis was transferred into sample bottle with ethylene diamine tetraacetate (anticoagulant) while those for serum biochemical indices were collected into a sterile sample bottle without anticoagulant. Haematological analysis was carried out using Erba Elite 580 Advanced fully automated haematology analyzer which uses a halogen tungsten lamp.

To ensure precision the equipment is adjusted at a reaction temperature and fluctuation of  $37.0 \pm 0.1$  °C, wavelength (340-900 nm), absorption (0-4 Abs), reagent volume (20-500 µL), and storage temperature (2-10 °C) before results were displayed via the visual display unit which uses software window XP 2000 database SQL server. Samples for serum biochemical indices were analyzed using a YSTE0202 Automated chemistry analyzer (YSTE 400, Guangzhou, China) and adjusted based on the manufacturer's recommendation to ensure accuracy in results.

Table 1. Ingredients and chemical composition of experimental diet expressed in dry matter.

Ingredients	Amount included (%)
Yellow corn	53.00
Soya bean meal	30.00
Fish meal	5.00
Wheat offal	5.10
Limestone	2.00
Bone meal	4.00
Mineral/Vitamin Premix	0.25
Methionine	0.20
Lysine	0.20
Salt	0.25
Total	100.00
Determined analysis (%)	
Metabolizable energy (MJ/kg <sup>-1</sup> )	12.50
Crude protein	22.91
Crude fibre	3.51
Ether extract	3.77
Ash	2.78
Calcium	1.62
Phosphorus	0.80

Note: 2.5 kilograms of grower's premix contained: Thiamine, 3000 mg, riboflavin, 6000 mg, pyridoxine, 3500 mg, cyanocobalamin, 1000 mg, niacin, 25,000 mg, Pantothenic acid, 12,000 mg, folate, 500 mg, biotin, 1000 mg, Retinyl acetate, 10,000 iu., cholecalciferol, 2,000,000 iu., tocopherol, 20,000 iu., ascorbic acid, 52,000 mg, Manganese, 8200 mg, Iron, 6,200 mg, Zinc, 300 mg, Copper, 200 mg, Cobalt, 150 mg, Iodine, 200 mg, Selenium, 100 mg, choline chloride, 50,000 mg. Source: Author, 2024.

### 2.5 Statistical analysis

All data (growth performance, haematology, serum biochemical indices) were analyzed by one-way analysis of variance using SPSS statistical software (Version 23.0 for Windows, SPSS, Inc., Chicago, IL, USA). Differences between treatment means were separated using *Duncan's* test. Significant differences were declared at  $p < 0.05$ .

### 3. Results and Discussion

As presented in Table 2, the growth performance of weaned pigs fed *C. fruticosa* leaf powder. Average daily weight gain, average daily feed intake, feed conversion ratio, and mortality rate were influenced by the dietary supplementation of *C. fruticosa* leaf powder and their values took the form of 0.29-0.46 kg, 0.68-0.77 kg, 1.73-2.34 and 1.0-3.0% correspondingly. Average daily weight gain and average daily feed intake of pigs fed 20 g *C. fruticosa* leaf powder/kg<sup>-1</sup> diet in treatment 2 (0.44 kg, 0.76 kg) and 40 g *C. fruticosa* leaf powder/kg<sup>-1</sup> diet in treatment 3 (0.45 kg, 0.77 kg) were very comparable ( $p > 0.05$ ) to those in treatment 4 (60 g *C. fruticosa* leaf powder/kg diet<sup>-1</sup>) (0.46 kg, 0.77 kg) and treatment 5 (80 g *C. fruticosa* leaf powder/kg diet<sup>-1</sup>) (0.46 kg, 0.77 kg) but significantly higher ( $p < 0.05$ ) than those fed treatment 1 (without *C. fruticosa* leaf powder). Mortality was higher in treatment 1 and lower in treatment 2 ( $p < 0.05$ ) while none was recorded in the other treatment.

The result obtained in this study revealed that *C. fruticosa* leaf powder can positively influence the growth of pigs through increased secretion of endogenous digestive enzymes which optimizes digestion and degradation of metabolic products as well as absorption and metabolic conversion of the supplied feed nutrients (Liz, 2020;

Alagbe, 2022). These activities are made possible by the presence of phyto-constituents in the *C. fruticosa* leaf. According to Olujimi (2024), *C. fruticosa* leaf contains phenolic compounds, steroids, tannins, alkaloids, flavonoids, and saponins which have numerous pharmacological properties (antimicrobial, antifungal, antioxidant, anti-helminthic, immune-stimulatory, antibacterial, hepato-protective, cytotoxic amongst others) and are recognized for their potential to improve growth performance and nutrient digestibility in pigs (Koy, 2020; Oluwafemi et al., 2021).

This observation aligns with the reports of Feldpausch et al. (2018) who recorded a numerical increase in weight gain of nursery pigs fed Origanum essential oil at 0.6%. Similar outcome was recorded by Costa et al. (2011) when phyto-genics were fed to weanling pigs. Average daily feed intake was also found to increase in *C. fruticosa* leaf powder-supplemented treatment which also translates to a better feed conversion ratio when compared to the control group. This suggests that *C. fruticosa* leaf powder has an appealing aroma that can enhance palatability, this is possibly due to the presence of flavonoids in the test ingredient (Daniel et al., 2023). The result obtained is in agreement with Clouard et al. (2012); and Cairo et al. (2018) when red pepper was supplemented in the diet of weanling pigs.

Phenolic compounds have also been suggested to possess antioxidant, antimicrobial and immuno-stimulatory properties (Ojediran et al., 2024) while tannins, alkaloids, and flavonoids have been reported for anti-inflammatory, anti-bacterial, antioxidant, hepato-protective and analgesic activities (Ojediran et al., 2024; Alagbe, 2023). This explains why mortality was lower in *C. fruticosa* leaf treatment relative to the control group. It shows that the *C. fruticosa* leaf can inhibit the growth of pathogenic bacteria and influence the proliferation of beneficial bacteria in the gut to maintain a stable gastrointestinal flora (Alagbe, 2024).

Table 2. Growth performance of weaned pigs fed *Cordyline fruticosa* leaf powder.

Variables	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	SEM
Number of animals	10.0	10.0	10.0	10.0	10.0	-
Duration of the study (days)	60.0	60.0	60.0	60.0	60.0	-
Initial body weight (kg)	9.77	9.75	9.76	9.75	9.74	0.01
Final body weight (kg)	27.18 <sup>b</sup>	36.17 <sup>a</sup>	36.92 <sup>a</sup>	37.05 <sup>a</sup>	37.07 <sup>a</sup>	0.26
Weight gain (kg)	17.41 <sup>b</sup>	26.42 <sup>a</sup>	27.16 <sup>a</sup>	27.30 <sup>a</sup>	27.33 <sup>a</sup>	0.11
Average daily weight gain (kg)	0.29 <sup>b</sup>	0.44 <sup>a</sup>	0.45 <sup>a</sup>	0.46 <sup>a</sup>	0.46 <sup>a</sup>	0.01
Total feed intake (kg)	40.91 <sup>b</sup>	45.88 <sup>a</sup>	46.17 <sup>a</sup>	46.22 <sup>a</sup>	46.25 <sup>a</sup>	0.37
Average daily feed intake (kg)	0.68 <sup>b</sup>	0.76 <sup>a</sup>	0.77 <sup>a</sup>	0.77 <sup>a</sup>	0.77 <sup>a</sup>	0.01
Feed conversion ratio	2.34 <sup>a</sup>	1.74 <sup>b</sup>	1.73 <sup>a</sup>	1.73 <sup>a</sup>	1.73 <sup>a</sup>	0.01
Mortality expressed in %	3.00	1.00	-	-	-	0.01

Note: Means on the same row having different superscripts are significantly different ( $p < 0.05$ ); SEM: Standard Error of Mean; treatment 1: basal diet without *Cordyline fruticosa* leaf powder; treatment 2: basal diet with 20 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 3: basal diet with 40 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 4: basal diet with 60 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 5: basal diet with 80 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>. Source: Author, 2024.

Haematological indices of weaned pigs fed *C. fruticosa* leaf powder is presented in (Table 3). Haemoglobin concentration, red blood cell, pack cell volume, total platelet count, mean platelet count, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, white blood cell, lymphocytes, and monocytes values took the form of 98.11-129.5 g/dL, 4.20-6.92 ( $\times 10^{12}/L$ ), 22.40-34.01%, 0.26-0.48%, 6.11-9.52 fl, 36.19-60.93 fl, 29.62-40.08 pg, 73.06-110.4 g/L, 8.92-12.11 ( $\times 10^9/L$ ), 7.08-13.51 ( $\times 10^9/L$ ) and 0.20-0.50 ( $\times 10^9/L$ ) accordingly. The haemoglobin count, red blood cell, pack cell volume, and total platelet counts were within the standard benchmark of 96.0-152.0 g/L, 4.70-7.00 ( $\times 10^{12}/L$ ), 20.58-35.86% and 0.13-0.61% cited by Yan et al. (2012); Merck's Veterinary Manual (2006). An increase in pack cell volume can occur as a result of polycythemia, dehydration, and lungs and kidney disease (Shittu and Alagbe, 2021). Low platelet count suggests vitamin 12 and folate deficiency, bone marrow infection, enlarged spleen, and other health conditions (John, 2024; Shittu et al., 2021). Low haemoglobin indicates a lack of oxygen in the tissues

which could affect the overall health of animals (Agubosi et al., 2022; Daniel et al., 2024).

Mean platelet volume, mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration were within the baseline values (6.99-12.76 fl), 35.25-65.23 fl, 29.40-40.79 pg and 70.80-263.1 (g/L) quoted by Zhang et al. (2012); Czech et al. (2018). Mean platelet volume can be used to make inference about platelet production in the bone marrow. Mean platelet volume is higher when there is destruction of platelets due to an inflammatory disease (Casas-Diaz et al., 2015). The mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration recorded in this study, denotes that the pigs were not anemic (Adewale et al., 2021). White blood cell count, lymphocytes, and monocytes count obtained in this experiment were within the estimated values [6.36-26.20 ( $\times 10^9/L$ )], [3.29-13.67 ( $\times 10^9/L$ )] and [0.12-0.71 ( $\times 10^9/L$ )] cited by Friendship et al. (1984). White blood cells and their differentials produce antibodies that fight against infection/disease in the body (Adewale et al., 2021; John, 2024).

Table 3. Haematological indices of weaned pigs fed *Cordyline fruticosa* leaf powder.

Variables	T1	T2	T3	T4	T5	SEM	Baseline
Haemoglobin (g/L)	98.11 <sup>c</sup>	110.6 <sup>b</sup>	121.8 <sup>a</sup>	127.7 <sup>a</sup>	129.5 <sup>a</sup>	6.35	96.0-152.0
Red blood cell ( $\times 10^{12}/L$ )	4.20 <sup>c</sup>	6.00 <sup>b</sup>	6.51 <sup>a</sup>	6.70 <sup>a</sup>	6.93 <sup>a</sup>	0.02	4.70-7.00
Pack cell volume (%)	22.40 <sup>c</sup>	30.26 <sup>b</sup>	33.86 <sup>a</sup>	33.90 <sup>a</sup>	34.01 <sup>a</sup>	0.60	20.58-35.86
Total platelet count (%)	0.26 <sup>c</sup>	0.38 <sup>b</sup>	0.41 <sup>a</sup>	0.46 <sup>a</sup>	0.48 <sup>a</sup>	0.01	0.13-0.61
Mean platelet volume (fl)	6.11 <sup>c</sup>	7.43 <sup>b</sup>	9.48 <sup>a</sup>	9.50 <sup>a</sup>	9.52 <sup>a</sup>	0.02	6.99-12.76
Mean corpuscular volume (fl)	36.19 <sup>c</sup>	46.80 <sup>b</sup>	59.02 <sup>a</sup>	60.80 <sup>a</sup>	60.93 <sup>a</sup>	2.81	35.25-65.23
Mean corpuscular haemoglobin (pg)	29.62 <sup>c</sup>	30.32 <sup>b</sup>	39.08 <sup>a</sup>	40.02 <sup>a</sup>	40.08 <sup>a</sup>	2.04	29.40-40.79
Mean corpuscular haemoglobin concentration (g/L)	73.06 <sup>c</sup>	99.80 <sup>b</sup>	102.3 <sup>a</sup>	108.6 <sup>a</sup>	110.4 <sup>a</sup>	5.92	70.80-263.1
White blood cell ( $\times 10^9/L$ )	8.92 <sup>c</sup>	10.08 <sup>b</sup>	11.25 <sup>a</sup>	12.03 <sup>a</sup>	12.11 <sup>a</sup>	0.16	6.36-26.20
Lymphocytes ( $\times 10^9/L$ )	7.08 <sup>c</sup>	9.90 <sup>b</sup>	13.95 <sup>a</sup>	13.05 <sup>a</sup>	13.51 <sup>a</sup>	0.12	3.29-14.67
Monocytes ( $\times 10^9/L$ )	0.20 <sup>c</sup>	0.37 <sup>b</sup>	0.42 <sup>a</sup>	0.49 <sup>a</sup>	0.50 <sup>a</sup>	0.01	0.12-0.71

Note: Means on the same row having different superscripts are significantly different ( $p < 0.05$ ); SEM: Standard Error of Mean; treatment 1: basal diet without *Cordyline fruticosa* leaf powder; treatment 2: basal diet with 20 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 3: basal diet with 40 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 4: basal diet with 60 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 5: basal diet with 80 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>. Source: Author, 2024.

Serum enzymes and minerals of weaned pigs fed *Cordyline fruticosa* leaf powder are presented in Table 4. Total protein, albumin, globulin, and glucose values which vary from 51.83-70.31 g/L, 27.02-39.23 g/L, 24.81-30.08 g/L, and 4.42-6.31 mmol/L were higher among pigs fed treatment 3 (40 g *C. fruticosa* leaf powder /kg diet), treatment 4 (60 g *C. fruticosa* leaf powder /kg diet) and treatment 5 (60 g *C. fruticosa* leaf powder/kg diet<sup>1</sup>), intermediate in treatment 2 (20 g *C. fruticosa* leaf powder /kg diet) and lower in treatment 1 (without *Cordyline fruticosa* leaf powder) ( $p < 0.05$ ) correspondingly.

Their values were within the quoted range of 40.00-75.00 g/L, 26.95-44.55 g/L, 20.00-35.00 g/dL cited by Yeom et al. (2012). Low serum total protein signifies liver or kidney impairment or improper protein digestion or absorption (Alagbe, 2024). Excessive glucose levels are recorded among animals during period of stress, malnutrition, or poor animal management (Muritala et al., 2022). In contrast, cholesterol levels which took the form of 1.76-2.94 mmol/L were higher in treatment 1 (without *Cordyline fruticosa* leaf powder) relative to the other treatments ( $p < 0.05$ ).

The values were within the normal range of 1.15-3.50 mmol/L cited by Perri et al. (2017). This implies that meat from animals is safe for consumers without the fear of heart disease (John, 2024; Olujimi, 2024). Total bilirubin, creatinine, and urea were not impacted ( $p < 0.05$ ) by the treatments, their values varied from [15.88-16.37 ( $\mu\text{mol/L}$ )], [75.16-76.29 ( $\mu\text{mol/L}$ )] and 2.59-2.75 mmol/L accordingly. However, the results were within

the values [2.05-20.86 ( $\mu\text{mol/L}$ )], [69.27-124.59 ( $\mu\text{mol/L}$ )], and 1.05-6.39 mmol/L quoted by Perri et al. (2017). Elevation in bilirubin level signifies level infection while creatinine and urea results show absence of renal impairment (Agubosi et al., 2022).

Table 4. Serum biochemical indices of weaned pigs fed *Cordyline fruticosa* leaf powder.

Variables	T1	T2	T3	T4	T5	SEM	Baseline values
Total protein (g/L)	51.83 <sup>c</sup>	59.55 <sup>b</sup>	69.68 <sup>a</sup>	70.20 <sup>a</sup>	70.31 <sup>a</sup>	0.97	40.00 – 75.00
Albumin (g/L)	27.02 <sup>c</sup>	29.15 <sup>b</sup>	39.02 <sup>a</sup>	39.11 <sup>a</sup>	39.23 <sup>a</sup>	0.11	26.95 – 44.55
Globulin (g/L)	24.81 <sup>c</sup>	30.40 <sup>b</sup>	30.67 <sup>a</sup>	30.09 <sup>a</sup>	30.08 <sup>a</sup>	0.10	20.00 – 35.00
Total bilirubin ( $\mu\text{mol/L}$ )	15.88	16.03	16.20	16.30	16.37	0.02	2.05 – 20.86
Creatinine ( $\mu\text{mol/L}$ )	75.16	76.07	76.13	76.20	76.29	0.86	69.27 – 124.59
Urea (mmol/L)	2.59	2.63	2.66	2.72	2.75	0.01	1.05 – 6.39
Glucose (mmol/L)	4.42 <sup>c</sup>	5.08 <sup>b</sup>	6.21 <sup>a</sup>	6.24 <sup>a</sup>	6.31 <sup>a</sup>	0.01	2.39 – 7.14
Cholesterol (mmol/L)	2.94 <sup>a</sup>	2.00 <sup>b</sup>	1.85 <sup>c</sup>	1.80 <sup>c</sup>	1.76 <sup>c</sup>	0.01	1.15 – 3.50

Note: Means on the same row having different superscripts are significantly different ( $P < 0.05$ ); SEM: Standard Error of Mean; treatment 1: basal diet without *Cordyline fruticosa* leaf powder; treatment 2: basal diet with 20 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 3: basal diet with 40 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 4: basal diet with 60 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 5: basal diet with 80 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>. Source: Author, 2024.

Serum enzymes and minerals of weaned pigs fed *C. fruticosa* leaf powder are presented in (Table 5). Alanine transaminase, aspartate aminotransferase, alkaline phosphatase, sodium and chloride values were not influenced ( $p > 0.05$ ) by the treatment and it took the form of [28.06-28.95 (U/L)], [65.91-67.02 (U/L)], [105.0-110.98 (U/L)], 133.4-138.6 (mmol/L) and 100.2-103.3 (mmol/L) correspondingly. Values were within the baselines of 27.68-104.86 (U/L), 28.57-109.12 (U/L), 54.10-200.86 (U/L), 99.72-164.7 mmol/L and 100.2-115.6 mmol/L predicted by Cooper et al. (2014).

The result on alanine transaminase, aspartate aminotransferase, and alkaline phosphatase obtained in this experiment denotes the absence of hepato-cellular disease (Singh et al., 2022). Calcium and phosphorus values consisted of 256-3.35 mmol/L and 1.64-2.91 mmol/L in that order. Results obtained were greater in treatment 3 (40 g *C. fruticosa* leaf powder/kg diet), treatment 4 (60 g *C. fruticosa* leaf powder/kg diet<sup>-1</sup>), and treatment 5 (80 g *C. fruticosa* leaf powder/kg diet<sup>-1</sup>), intermediary in treatment 2 (20 g *C. fruticosa* leaf powder/kg diet<sup>-1</sup>) and lesser in treatment 1 (no *C. fruticosa* leaf powder). Calcium and Phosphorus are responsible for maintaining fluid, and pH balance and are active in the nerve and muscle functioning of animals (Musa et al., 2021).

Table 5. Serum enzymes and minerals of weaned pigs fed *Cordyline fruticosa* leaf powder.

Variables	T1	T2	T3	T4	T5	SEM	Baseline values
Alanine transaminase (U/L)	28.06	28.61	28.80	28.91	28.95	0.08	27.68-104.86
Aspartate amino transferase (U/L)	65.91	65.80	66.90	66.95	67.02	0.05	28.57-109.12
Alkaline phosphatase (U/L)	110.98	106.41	105.11	105.02	105.00	0.17	54.10-200.86
Calcium (mmol/L)	2.56 <sup>c</sup>	3.00 <sup>b</sup>	3.21 <sup>a</sup>	3.30 <sup>a</sup>	3.35 <sup>a</sup>	0.01	2.36-3.46
Phosphorus (mmol/L)	1.64 <sup>c</sup>	2.10 <sup>b</sup>	2.80 <sup>a</sup>	2.87 <sup>a</sup>	2.91 <sup>a</sup>	0.01	1.49-3.92
Sodium (mmol/L)	133.4	134.4	134.1	135.2	138.8	0.96	99.72-164.7
Chloride (mmol/L)	100.2	102.5	102.9	103.1	103.3	1.12	100.2-115.6

Note: Means on the same row having different superscripts are significantly different ( $p < 0.05$ ); SEM: Standard Error of Mean; treatment 1: basal diet without *Cordyline fruticosa* leaf powder; treatment 2: basal diet with 20 g *Cordyline fruticosa* leaf powder/kg; treatment 3: basal diet with 40 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 4: basal diet with 60 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>; treatment 5: basal diet with 80 g *Cordyline fruticosa* leaf powder/kg<sup>-1</sup>.

*fruticosa* leaf powder/kg<sup>-1</sup>.

#### 4. Conclusions

In conclusion, *Cordyline fruticosa* leaf powder possesses several pharmacological properties – antimicrobial, antifungal, flavoring, anti-bacterial, anti-inflammatory, antiviral, hepato-stimulatory, immune-modulatory and physiological amongst others, all of which are important for the performance-enhancing effect in pigs. Dietary supplementation of *C. fruticosa* leaf powder up to 80 g/kg<sup>-1</sup> diet significantly influenced the final body weight and blood metabolites examined without compromising the health status of the animal. Therefore, supplementation of *Cordyline fruticosa* leaf powder will help to provide a natural alternative to antibiotics, thus promoting food safety and addressing the increasing cases of antimicrobial resistance.

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#### 6. Authors Contributions

Alagbe Olujimi John designed the experiment, data collection, statistical analysis, and writing of the manuscript.

#### 7. Conflicts of Interest

No conflicts of interest.

#### 8. Ethics Approval

Yes, applicable. The trial was carried out in accordance with the guidelines that had been authorized by the ethics council of Sumitra Research Institute, India (VN/114/2022).

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