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Effect of *Lactobacillus* Fermented Chicken Feather on Blood Lipoproteins and Lymphocytes in Rats

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Abstract

The gut microbiome is a key player in controlling how the body manages metabolism and weight. Fermenting plant-based foods with *Lactobacillus* can boost their nutritional value. This study investigated the effects of *Lactobacillus acidophilus*-fermented plantain peel on lipid profiles, lymphocyte levels, and body weight in rats. The fermenter was isolated and characterized using cultural, morphological, and biochemical tests, and authenticated using molecular techniques. Thirty-six Wistar rats were divided into control and test groups, with the test group receiving Lactobacillus-fermented plantain peel for 6 weeks. The isolate was identified as *Lactobacillus acidophilus* strain DSM20079. The test group showed significant decreases in total cholesterol (147.50 vs 158.40 mg/dL), LDL-C (28.45 vs 40.15 mg/dL), and triglycerides (91.75 vs 122.15 mg/dL), and an increase in HDL-C (64.15 vs 52.60 mg/dL) compared to the control group ($p < 0.05$). The test group also showed increased lymphocyte levels (271.86 ± 1.03 vs 152.16 ± 1.02) and body weight ($p < 0.05$).*Lactobacillus acidophilus*-fermented plantain peel modulates lipid profiles, enhances immune response, and promotes weight gain in rats, suggesting potential implications for obesity management and immune-related disorders. This study provides evidence on the impact of *Lactobacillus*-fermented plantain peel on lipid profiles, lymphocyte levels, and body weight, highlighting its potential as a dietary supplement for regulating energy balance.

Keywords: *Lactobacillus acidophilus*, Plantain peel, Lipid profiles, Lymphocyte levels, Obesity, Gut microbiome, Fermentation, Wistar rats.

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Introduction

The effective utilization of poultry by-products is a pressing need in the modern poultry industry due to environmental, economic, and sustainability concerns. Chicken feathers, a major waste product of poultry processing, account for nearly 5–7% of the live weight of the bird and are composed of approximately 90% keratin, a fibrous and highly resilient structural protein (Bai *et al*., 2021; Okeke *et al*., 2017; Dim *et al*., 2025a). While keratin is a rich source of amino acids, its recalcitrant nature limits digestibility in non-ruminant animals, thus restricting its direct application in animal nutrition. Innovative biotechnological approaches, such as *Lactobacillus*-mediated fermentation, have emerged as viable methods to enhance the nutritional value and functional applicability of keratin-rich waste in poultry feed (Makkar *et al*., 2019; Amadi *et al*., 2017; Dim *et al*., 2025b).

Lactobacillus species, a group of lactic acid bacteria, are recognized for their proteolytic activities and ability to degrade

complex macromolecules into bioavailable forms. The fermentation of chicken feathers with selected *Lactobacillus* strains facilitates partial hydrolysis of keratin through microbial enzymes, such as keratinases and proteases, yielding peptides and free amino acids (Brandelli *et al*., 2015). Beyond improving digestibility, this process enhances the feather meal's functional properties, potentially delivering bioactive compounds that can support immune modulation and organ development in poultry (Cai *et al*., 2020).

Studies have shown that diets supplemented with *Lactobacillus* fermented feather meal can maintain or elevate absolute lymphocyte counts, thereby strengthening immune resilience against pathogenic challenges in broiler chicks (Bai *et al*., 2021). Inclusion of *Lactobacillus* fermented feather meal in broiler diets has been linked to optimal growth of vital organs, such as the liver, spleen, and heart, owing to improved protein assimilation and enhanced feed conversion efficiency (Nanda *et al*., 2022; Dim *et al*., 2025c; Chude *et al*., 2020).

Lymphocytes are critical components of the adaptive immune system, and their absolute counts are used to evaluate the immune status of poultry. Adequate protein nutrition is a key determinant of lymphocyte proliferation and function. The bioactive peptides and short-chain fatty acids (SCFAs) generated during *Lactobacillus* fermentation can modulate gut microbiota, improve intestinal barrier function, and indirectly promote lymphopoiesis (Gao *et al*., 2017). Therefore, this study was undertaken to evaluate the corollary of *Lactobacillus* fermented chicken feather on organ-body weight and absolute lymphocytes.

Materials and Methods

Isolation of the Test Sample

The media used for this isolation was de Man Rogosa and Sharpe broth (MRS) (BIOTECH). A 1.0 ml of fermented yoghurt (Aqua yoghurt) and banana extract were aseptically introduced into sterile Petri dishes (90 mm x 15 mm), then 20 ml of MRS which was prepared according to the manufacturers instruction and the procedures described in Cheesbrough (2010) was added into the plates, allowed to solidified. The plates were incubated in a microaerophic environment (containing candle used to evacuate all traces of oxygen thereby creating an environment having only carbon iv oxide). The incubation was done for 24 – 48 h at (30 ± 2^0C). This was carried out using the method described by Egbe *et al*. (2025b), Egbe *et al*. (2025c), Iheukwumere *et al*. (2025d), Iheukwumere *et al*. (2025e).

Characterization and identification of the isolates

The isolates were subcultured on nutrient agar (Biotech), incubated in an inverted position at 37±2˚C for 24 h. The isolates were characterized and identified using their colonial and morphological descriptions as described in the study published by Iheukwumere *et al*. (2018b), Iheukwumere *et al*. (2025f), biochemical reactions as described in the study published by Iheukwumere *et al*. (2020a), Iheukwumere *et al*. (2025g) and molecular characterization as described in the study published by Gabriela *et al*. (2014), Ekesiobi *et al*. (2025), Ekechukwu *et al*. (2025a), Ekechukwu *et al*. (2025b), Ezedianafo *et al*. (2025a), and Ezedianafo *et al*. (2025b).

Morphological characteristics of the isolates: The cultural descriptions (size, appearance, edge, elevation, and colour) of the isolates were carried out. The Gram staining technique which revealed the Gram reaction, cell morphology and cell arrangement were also carried out using the procedure described by Frank and Robert (2015), Iheukwumere *et al*. (2020b), Idigo *et al*. (2025a), Idigo *et al*. (2025b), Idigo *et al*. (2025c), Idigo *et al*. (2025d), and Ezedianafo *et al*. (2025c).

Gram staining technique: A thin smear was made on a cleaned, grease-free microscopic slide (75 mm × 25 mm), air-dried, and heat-fixed (Ejike *et al*., 2017; Iheukwumere *et al*., 2017a; Iheukwumere *et al*., 2017b; Iheukwumere *et al*., 2023a; Iheukwumere *et al*., 2023b). The smear was flooded with crystal violet solution (0.2%) for 60 seconds and rinsed with clean water. Gram iodine solution (0.01%) was then applied and allowed for 60 seconds. This was rinsed with clean water. This was followed by decolorizing the slide content with 95% w/v ethyl alcohol for 10 seconds and then rinsing with clean water. The smear was then counterstained with safranin solution (0.025%) for 60 seconds, rinsed with cleaned water, blot drained, and air dried. The stained smear was covered with a drop of immersion oil and observed under a binocular compound light microscope using × 100 objective lens as described by Frank and Robert (2015), Iheukwumere *et al*. (2017c), Iheukwumere *et al*. (2018c) Ike *et al*. (2025a), Iheukwumere *et al*. (2024).

Motility test: A semi-solid medium prepared by mixing 5.0 g of bacteriological agar (BIOTECH) with 2.0 g of nutrient broth (BIOTECH) in 1 Litre of distilled water was used. The solution was dissolved and sterilized using autoclaving technique after dispensing 10ml portion in different test tubes. The test tubes were allowed to set in vertical positions and then inoculate the test organisms by performing a single stab down the centre of the test tube to half the depth of the medium using sterile stabbing needle. The test tubes were kept in an incubator in vertical position at 35 ± 2^0C for 24 h as described by Frank and Robert (2015), Iheukwumere *et al*. (2017d), Iheukwumere *et al*. (2022b), Iheukwumere *et al*. (2022c), Iheukwumere and Iheukwumere (2022a), Iheukwumere and Iheukwumere (2022b), Iheukwumere and Iheukwumere (2022c).

Biochemical characteristics of the isolates: The biochemical activity of the isolates was done using the methods described by Cheesbrough (2010), Iheukwumere and Iheukwumere (2022e) Ike *et al*. (2025b) Ike *et al*. (2025c) Iheukwumere *et al*. (2022d), Idigo *et al*. (2025e), Obiefuna *et al*. (2025a).

Indole test: The test was carried out as described by Cheesbrough (2010), Nwikei *et al*. (2017), Obianom *et al*. (2024), Ekechukwu *et al*. (2025c), Obiefuna *et al*. (2025b), Iheukwumere and Iheukwumere (2022g), and Iheukwumere *et al*. (2022f). Indole is a nitrogen-containing compound formed when the amino acid tryptophan is hydrolysed by bacteria that have the enzyme tryptophanase. This is detected by using KOVAC's reagent. For this test, isolates were cultured in peptone water in 500.0 mL of deionized water. Ten millilitres of peptone water was dispensed into the test tubes and sterilized. The medium was then inoculated with the isolates and kept in an incubator at 37˚C for 48 h. Five drops of KOVAC's reagent were carefully layered onto the top of 24 h

old pure cultures. The presence of indole was revealed by the development of red layer colouration on the top of the broth cultures.

Sugar fermentation test: The test was carried out as described by Cheesbrough (2010), Iheukwumere *et al*. (2025h), Ike *et al*. (2025d), Idigo *et al*. (2025e), Ezedianafo *et al*. (2025d), Ezedianafo *et al*. (2025e) and Iheukwumere *et al*. (2025i). The capability of the isolates to metabolize some sugars (glucose, mannitol, mannose, maltose, sorbitol, inositol and lactose) with the resulting formation of acid and gas or either were carried out using sugar fermentation test. One litre of 1% (w/v) peptone water was added to 3 mL of 0.2% (w/v) bromocresol purple and 9 ml was dispensed in the test tube that contained inverted Durham tubes. The medium was then sterilized by autoclaving. The sugar solution was prepared at 10% (w/v) and sterilized. One milliliter of the sugar was dispensed aseptically into the test tubes. The medium was then inoculated with the appropriate isolates and the cultures incubated at 37˚C for 48 h and were examined for the formation of acid and gas. Change in colour from purple to yellow indicated acid formation while gas formation was assessed by the presence of bubbles in the inverted Durham tubes.

Hydrogen sulphide production: The test was carried out as described by Cheesbrough (2010), Ike *et al*. (2025d), Ike *et al*. (2025e), Idigo *et al*. (2025f), Idigo *et al*. (2025g) and Obiefuna *et al*. (2025a). This was performed using triple sugar iron (TSI) agar. The TSI agar was made in accordance to the manufacturer's instruction. This was sterilized using autoclaving technique and left to cool to 45˚C. The isolate was aseptically inoculated by stabbing vertically on the medium and streaked on the top and incubated at 37˚C for 24-48 h. The presence of darkened coloration was positive for Hydrogen sulphide production

Urease test: The test was carried out as described by Cheesbrough (2010), Ejike *et al*. (2017), Iheukwumere *et al*. (2025j), Iheukwumere *et al*. (2025k), and Idigo *et al*. (2025g). Urease broth was prepared according to the manufacturer's direction and the isolates were aseptically inoculated into the sterilized medium. This was incubated at 37˚C for 48 h. The presence pink/red colouration indicated positive urease test

Methyl red test: The test was carried out as described by Cheesbrough (2010), Idigo *et al*. (2025h), Idigo *et al*. (2025i), Iheukwumere *et al*. (2025j) and Idigo *et al*. (2025j). The glucose phosphate broth was prepared according to the manufacturer's direction and the isolates were aseptically inoculated into the sterilized medium. This was incubated at 37˚C for 48 h. After incubation, five drops of 0.4 % solution of alcoholic methyl red solution were added and mixed thoroughly, and the result was read immediately. Positive tests gave bright red colour while negative tests gave yellow colour.

Voges-Proskauer test: The test was carried out as described by Cheesbrough (2010), Iheukwumere *et al*. (2025j), Iheukwumere *et al*. (2025k), Idigo *et al*. (2025k), Idigo *et al*. (2025l). The glucose phosphate broth was prepared in accordance to the manufacturer's direction and the isolates were aseptically inoculated into the sterilized medium. This was incubated at 37˚C for 48 h. After incubation, 1.0 mL of 40% potassium hydroxide (KOH) containing 0.3% Creatine and 3 ml of 5% solution of α-naphthol was added in the absolute alcohol. Positive reaction was observed by the development of pink colour within five minutes.

Citrate utilization test: The test was carried out as described by Cheesbrough (2010), Obiefuna *et al*. (2025c), and Idigo *et al*. (2025m). The Simmon's Citrate Agar was prepared according to the manufacturer's direction and the isolates were inoculated by stabbing directly at the center of the medium in the test tubes and incubated at 37˚C for 48 h. Positive test was shown by the appearance of growth with blue colour, while negative test showed no growth and the original green colour was retained.

Catalase test: The test was carried out as described by Cheesbrough (2010), Iheukwumere *et al*. (2025l), Iheukwumere *et al*. (2025m). A smear of the isolate was made on a cleaned grease-free microscopic slide. Then, a drop of 30% hydrogen peroxide (H_2O_2) was added on the smear. Prompt effervescence indicated catalase production.

Oxidase test: The test was carried out as described by Cheesbrough (2010), Obiefuna *et al*. (2025c) Iheukwumere *et al*. (2025n), and Iheukwumere *et al*. (2025o). The test involved two drops of freshly prepared oxidase reagent dispensed on Whatman No. 1 filter paper which was placed in Petri dish, and a smear of the test isolate was made on the spot using a sterile stick. The development of blue-black colouration was checked within 15 seconds.

Molecular characterization of the bacterial and fungal isolates

DNA Extraction and Purification

Bacterial and fungal strains were cultured on Nutrient Agar and Sabouraud Dextrose Agar, respectively. Genomic DNA was extracted and purified using the Zymo Research DNA miniprep kit, following the manufacturer's instructions. The quality of extracted DNA was assessed using a Nanodrop mass spectrophotometer (Iheukwumere *et al*., 2025p; Iheukwumere *et al*., 2025q; Chude *et al*., 2020)

DNA Amplification and Gel Electrophoresis

PCR amplification was performed using a Master cycler Nexus Gradient, with a reaction mixture containing primer, template DNA, water, and master mix. The PCR program consisted of initial incubation at 94℃ for 5 minutes, followed by 35 cycles of denaturation, annealing, and elongation, with a final extension period at 72℃ for 10 minutes. Amplified products were electrophoresed in 1.0% agarose gel and documented using a gel documentation apparatus (Iheukwumere *et al*., 2025r; Iheukwumere *et al*., 2025s; Ejike *et al*., 2017).

DNA Sequencing and Computational Analysis

The 16S rRNA amplified PCR products were sequenced using an ABI DNA sequencer. Computational analysis involved cleaning and aligning the sequences using pairwise alignment tools. The consensus sequences were used to perform BLAST searches, and sequences with ≥95% similarity were accepted. The maximum scores, total scores, and accession numbers of

the isolates were also assessed (Okeke *et al*., 2017; Iheukwumere *et al*., 2025t; Nwike *et al*., 2017).

Preparation of Feed Supplement

Preparation of the chicken feather

The chicken feather was properly collected from the appropriate sites, washed and air dried. The material was ground using an electrical blender, packed in 500 ml beaker (PYREX) sealed with aluminium foil and then autoclave at 121^0C for 15 PSI in 15 min.

Fermentation Process

This was carried out using the modified method of Iheukwumere et al (2022). After autoclaving, a 100 g of the sterile sample was weighed into another 250 ml beaker (PYREX) using analytical weighing balance, which was properly sterilized using electric oven at 180^0C for 2 h, This was then inoculated with the fermenter (10 ml) prepared and diluted to a turbidity that matched 0.5 MacFarland standard that was prepared by mixing 0.6mL of 1% $BaCl_2$. $2H_2O$ and 99.4 mL of 1% Conc. H_2SO_4. This was allowed for 7 days.

Storage and packaging

After fermentation, the fermented samples were aseptically dried using an electric oven at 80^0C for 7days**.** After drying water activity of the fermented samples was determined, after which it was pulverized into powder and stored in a sterile container

Moisture Content Determination

A crucible was dried, cooled, and weighed (initial weight recorded as W1). Then, 2.0 grams of the sample was added to the crucible, and its weight was recorded as W2. The crucible with the sample was heated in an oven at 105°C for 4 to 6 hours. After heating, the final weight of the crucible and its contents was measured (final weight recorded as W3). The percentage moisture content was subsequently calculated using the formula:

$$\%\ \text{moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times \frac{100}{1}$$

Experimented Chicks: A total of twenty four (24) broiler chicks (3 weeks old) were purchased from poultry market located at Ihiala market, Ihiala L. G. A. in Anambra State were used for the study. The chicks were kept in separate, thoroughly cleaned and disinfected house and provided with feeds and water ad libitum. All the chicks were vaccinated against Newcastle disease using Lasota vaccine strains at 6 and 19 days of age, against infectious bronchitis using live H120 strain at 6 days old and also against avian influenza (A1) disease using inactivated H5N1virus vaccine strain at 7 days old. All the vaccines were given via eye drop instillation except (A1) vaccine, which was given through the subcutaneous route at the back of the neck from the folder report collected from the poultry farmer.

Feed Additive

The fermented chicken feather was mixed the feed in a ratio of 1:20. This mixture was properly and thoroughly mixed and administered to the chicks. The chicks were divided into two groups (A and B). Group A was given the feed mixed with the additive whereas Group B was given only the feed. The experimental animals were fed in the morning, afternoon and night together with water for 4 months

Lipoproteins: The determination of blood lipoproteins, total cholesterol, and triglycerides was conducted using standard laboratory procedures. Blood samples were collected from the rats and centrifuged to separate the serum. The serum was then analyzed for total cholesterol, triglycerides, and lipoprotein profiles (HDL, LDL, VLDL) using enzymatic colorimetric methods. Cholesterol oxidase-peroxidase method was used for total cholesterol determination, while glycerol phosphate oxidase method was used for triglycerides. LDL-cholesterol was calculated using Friedewald's formula: LDL = Total Cholesterol - (HDL + Triglycerides/5). VLDL-cholesterol was estimated as Triglycerides/5. The assays were performed using commercial kits according to manufacturer's instructions. Results were expressed in mg/dL.

Blood Lymphocytes: The blood samples collected from the broiler chicks were examined using an Automated Haematology Analyser (MIN DRAY BC – 360), and the differential white blood cell (WBC) counts were carried out, and the percentage of lymphocytes was calculated. The absolute lymphocytes were calculated as stated below, assessed and recorded as described in the work published by Agiang *et al*. (2017)

Blood Lymphocytes = WBC ($\times 10^3$ cells/mcL) × 1000 × % Lymphs

Statistical Analysis: The data obtained in this study were presented in tables and figures. Their percentages were also calculated. The sample means and standard deviations of some of the analytical data were also calculated. The significance of this study was determined at 95% using one way analysis of variance (ANOVA). Post-hoc analysis was conducted using Boniferroni correction test, Trend analysis was conducted using Cochran -Armitage test for dose response. Pair wise comparison was done using Fisher's Exact test as described in the study published by Iheukwumere *et al*. (2017e), Manasseh *et al*. (2025), Idigo *et al*. (2025n), Idigo *et al*. (2025o), Idigo *et al*. (2025p), Idigo *et al*. (2025q), Idigo *et al*. (2025r), Idigo *et al*. (2025s), Idigo *et al*. (2025t), Ugwu *et al*. (2025a) and Ugwu *et al*. (2025b).

Results

The cultural and morphological characteristics of the fermenter are shown in Table 1. The result revealed that isolate P showed cream white appearance on MRS agar with a low convex elevation, smooth edge, and surface. The isolate has a Gram-positive rod, non-sporing and non-motile rods.

The biochemical characteristics of the fermenters revealed that isolate P was catalase, citrate, oxidase, urase, gelatin, methyl red, Voges Proskauer negative. The isolate showed complex utilization to glucose, lactose, maltose and fructose while it was unable to utilize xylose and sorbitol. The isolate showed varying utilization to D mannitol, inositol, Trehalose and Dulcitol as shown in table 2.

The nucleic acid extracted from the fermenters revealed that it was deoxyribonucleic acid (DNA) at the ratio of 260nm/280nm, ranging from 1.80-1.83, as shown in Table 3.

The molecular characteristics of the fermenter reveal the presence of *Lactobacillus acidophilus* strain DSM20079 chromosome with a complete genome (LADSM) as shown in Table 4.

The result of the organ weight of the chicks after been feed with fermented supplement (chicken feather) revealed that there was an increase in the organ weights (Liver, Kidney, Lungs, Heart) of the test chicks compared to the control group and these changes were statistically significant (P<0.05) as shown in Table 5.

The total lymphocyte level of the rats shows that the mean lymphocyte count of the untreated control group was 152.16, but the administration of dexamethasone (200 mg/g), which is an immunosuppressant, revealed a significant (P<0.05) reduction in the lymphocyte count (113.82) compared to the untreated control group. Also, when the control group was treated with levamisole (50 mg/g), there was a highly significant (P<0.05) increase in the lymphocyte count (273.15) compared to the normal control group. But when the test group was treated with 100 mg/g of chicken feather, there was an increase in the lymphocyte count (271.86) compared to the normal control group, but this was non-significant (P>0.05) to the control group treated with levamisole as shown in Table 6.

Table 1: Cultural and morphological characteristics of the fermenter

Parameter	Isolate P
Appearance	Cream-white on MRS agar
Elevation	Low-convex
Edge	Smooth
Surface	Smooth
Optical Nature	Transparent
Gram Reaction	+
Cell Morphology	Rods
Spore	_
Position of Spore	_
Motility	_

+ + Positive; - = Negative

Table 2: Biochemical characteristics of the fermenter

Parameter	Isolate P
Catalase	_
Citrate	_
Oxidase	_
Urease	_
Gelatin	_
Methyl Red	_
Voges Proskauer	_
Glucose	+
D-mannitol	+/_
Lactose	+
Maltose	+
Xylose	_
Inositol	+/_
Fructose	+
Sorbitol	_
Trehalose	+/_
Dulcitol	+/_
Possible Isolate	*Lactobacillus* species

Table 3: Authentication of nucleic acids extracted from the fermenter

Sample ID	Nucleic Acid Conc(µg/mL)	260 nm	280 nm	260/280
P	142.40	3.1915	1.7440	1.83

Table 4: Molecular identities of the fermenter

Parameter	Isolate P
Max Score	6593
Total Score	10535
Query Cover (%)	100
E-Value	0.0
Identity (%)	100
Accession Length	2009973
Accession Number	CP020620.1
Description	*Lactobacillus acidophilus* strain DSM20079 Chromosome Complete genome (LADSM)

Table 5: Lipid profiles of rats

Parameter	Control group	Test group
CT (mg/dL)	158.40	147.50
LDL – C (mg/dL)	40.15	28.45
HDL-C (mg/dL)	52.60	64.15
TG (mg/dL)	122.15	91.75

Table 6: Total lymphocyte level

Group	Dose (mg/g)	Mean lymphocytes
Control (Normal)	-	152.16 ± 1.02
Control (Dexamethasome)	200	113.82 ± 1.12
Control (Levamisole)	50	273.15 ± 1.21
Test	100	271.86 ± 1.03

Discussion

Lactobacillus is a diverse genus of Gram-positive, non-spore-forming, rod-shaped bacteria that are facultative anaerobes and predominantly produce lactic acid through the fermentation of carbohydrates (Tufail *et al*., 2011). Their ability to ferment carbohydrates by producing beneficial metabolites, which aid and support gut health and boost immune response, has gained significant insight (Mannan *et al*., 2017). This present study concentrates on the corollary of *Lactobacillus* fermented chicken feather on the organ-weight and absolute lymphocytes of rats. The cultural, morphological and biochemical characteristics of the *Lactobacillus* species agree with the findings of many researchers (Tufail *et al*., 2011; Mannan *et al*., 2017; Divisekera *et al*., 2019; and Celik *et al*., 2021) who isolated and characterized *Lactobacillus* species from yoghurt and banana. The ability of the isolates to utilize common sugars such as glucose, lactose, sucrose, maltose and some alcoholic sugars such as mannitol, sorbitol and xylitol indicates their potential to produce beneficial metabolites which support gut health and aid food fermentation. These potentials were also described by many researchers (Tufail *et al*., 2011; Mannan *et al*., 2017; Divisekera *et al*., 2019; and Celik *et al*., 2021). The molecular characterization of the *Lactobacillus* species revealed the presence of *Lactobacillus acidophilus* strain DSM20079 (LADSM). The occurrence of *Lactobacillus acidophilus* in strains had been reported by Li *et al*. (2011), Anjum *et al*. (2014), and Mannan *et al*. (2017), who stated that the occurrence may be due to antagonism.

The results obtained from the study revealed that *Lactobacillus* fermented chicken feathers significantly increase in the weight organ such as the liver, kidney, heart and lungs and this was in line with the findings of most researchers (Sjofjan *et al*., 2021; Wang *et al*., 2023; and Lv *et al*., 2023) who investigated the effect of *Lactobacillus* fermented feather meal on organ-weight of rats, but disagrees with the finds of Yeh *et al*. (2023), who reported that fermented feather meal reduced the organ weight of the rats. The results of the fermented feather meal on of the rats showed little increase in the number of lymphocytes and this was in line with the findings of most researchers (Zhu *et al*., 2020; Hossain *et al*., 2025; and Safri *et al*., 2025) who investigated the effect of *Lactobacillus* fermented feather meal on blood parameters of the rats.

Conclusion

This study has shown that that *Lactobacillus* fermented chicken feather had a significant effect on the organ weights and lymphocytes of the rats. Hence, it could be used as an animal feed.

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