IPS Journal of Nutrition and Food Science
ISSN: 3115-5391
IPS J Nutr Food Sci, 6(1): 735-745 (2026)
DOI: https://doi.org/10.54117/x7jfq263

Assessment of Fermented Chicken Feather Mixed with Fish Meal as a Chicken Additive for Healthy Broiler Chicks

Ezeoke, F. C.[1], Iheukwumere, I. H.[2,] Iheukwumere, C. M.[3], Unaeze, B. C.[4], Ezendianefo, J. N.[5], Abba, O.[6], Idigo, M. A.[7], Aniekwu, C. C.[3], Anagor, I. S.[8], Ochibulu, S. C.[2] and Nnadozie, H. C.[2]

[1]Department of Animal Science, Faculty of Agriculture, Chukwuemeka Odumegwu Ojukwu University, Uli, Campus, Anambra State, Nigeria.
[2]Department of Microbiology, Faculty of Natural Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli, Campus, Anambra State, Nigeria.
[3]Department of Applied Microbiology and Brewing, Faculty of Biosciences, Nnamdi Azikiwe University, Awka, Nigeria.
[4]Department of Microbiology, University of Agriculture and Environmental Sciences, Umuagwo, Imo State, Nigeria.
[5]Department of Microbiology, Tansian Universiy, Umunya, Anambra State, Nigeria.
[6]Department of Microbiology, Federal University of Gusau, Zamfara State.
[7]Department of Biological Sciences, Faculty of Natural Sciences, Chukwuemeka Odumegwu Ojukwu University, Uli, Campus, Anambra State, Nigeria.
[8]Medical Microbiology and Parasitology, Faculty of Basic Clinical Sciences, Nnamdi Azikiwe University, Nnewi Campus.

*Corresponding author email: fc.ezeoke@coou.edu.ng / ik.iheukwumere@coou.edu.ng

Abstract

Maintaining healthy gut function in chicks is crucial for the poultry industry, as it impacts of growth and productivity. This study aimed to investigate the effects of *Lactobacillus acidophilus*-fermented chicken feather and bean chaff on modulating short-chain fatty acids (SCFAs) in chick gut and growth performance. The fermenter was isolated and characterized using cultural, morphological, and biochemical tests, and authenticated using molecular techniques. The isolate was identified as *Lactobacillus acidophilus* strain DSM20079. The SCFAs profile, body weights, organ weights, feed intake, and hematological indices of the control and test groups were analyzed. The test group also showed improved body weights, feed intake, and hematological indices. Statistical analysis revealed significant differences ($p < 0.05$) in the levels of SCFAs, body weights, and hematological indices between the test and control groups. The study concluded that *Lactobacillus acidophilus*-fermented chicken feather and bean chaff promotes growth, and enhances gut health in chicks. This study contributes to knowledge by providing evidence on the prebiotic potential of *Lactobacillus acidophilus*-fermented chicken feather and bean chaff in promoting gut health in poultry.

Keywords: *Lactobacillus acidophilus*, Chicken feather, Bean chaff, short-chain fatty acids, Gut health, Prebiotic, Poultry, Growth performance.

Article History
Received: 24 Dec 2025
Accepted: 28 Jan 2026
Published: 11 Feb 2026

Scan QR Code to view[1]

How to cite this paper: Ezeoke, F. C., Iheukwumere, I. H., Iheukwumere, C. M., Unaeze, B. C., Ezendianefo, J. N., Abba, O., Idigo, M. A., Aniekwu, C. C., Anagor, I. S., Ochibulu, S. C., & Nnadozie, H. C. (2026). *Assessment of fermented chicken feather mixed with fish meal as a chicken additive for healthy broiler chicks*. IPS Journal of Nutrition and Food Science, 6(1), 735–745. https://doi.org/10.54117/x7jfq263

Introduction

The rapid growth of global poultry production has intensified the demand for high-quality protein sources in broiler chick diets. Traditionally, protein-rich ingredients such as soybean meal and fish meal have been central to poultry nutrition because of their high digestibility and balanced amino acid profiles. However, these conventional feed sources are increasingly challenged by cost fluctuations, competition with human food systems, and environmental sustainability concerns (Wang *et al*., 2022; Tacon and Metian, 2008; Okeke *et al*., 2017; Dim *et al*., 2025a). In particular, the heavy reliance on fish meal has raised ecological issues related to overfishing and habitat depletion, creating an urgent need for alternative feed ingredients that are both nutritionally adequate and economically viable.

One underutilized but promising resource is chicken feather waste, a by-product of poultry processing that constitutes approximately 5–7 % of a bird's live weight (Adeogun *et al*., 2020). Feathers are composed primarily of keratin, a fibrous protein notable for its high nitrogen content and strong disulfide bonds, which make it resistant to enzymatic digestion by non-ruminants. In their raw form, feathers have limited nutritional value for poultry; however, advances in

bioprocessing techniques, particularly microbial fermentation, have enabled the conversion of keratin into digestible peptides and amino acids (Guo *et al*., 2012; Amadi *et al*., 2017; Dim *et al*., 2025b). Fermentation using microorganisms such as *Bacillus subtilis* and *Aspergillus niger* not only hydrolyzes keratin but can also enhance the bioavailability of essential amino acids like lysine, methionine, and cysteine, thereby improving growth performance when included in broiler diets (Wang *et al*., 2022).

Fish meal remains the gold standard among animal-derived protein sources for poultry, offering a balanced amino acid profile, high digestibility, and excellent palatability (Gupta and Cheng, 2015; Dim *et al*., 2025c; Chude *et al*., 2020). Nevertheless, its high market price and sustainability concerns limit its availability, especially in developing regions. Combining fermented chicken feather meal (FFM) with fish meal offers a promising strategy to reduce dependence on fish meal while maintaining or even improving nutritional quality. The inclusion of fish meal can compensate for certain amino acid limitations in feather-derived proteins, while fermentation enhances digestibility and creates value from what would otherwise be a waste product. Furthermore, fermentation can introduce bioactive compounds such as organic acids and enzymes, which may improve gut health and nutrient absorption in broiler chicks (Hur *et al*., 2014).

Studies have shown that partial replacement of fish meal with fermented feather protein does not compromise growth performance, and in some cases can enhance feed efficiency and reduce production costs (Taghipoor *et al*., 2020; Adeogun *et al*., 2020). Taghipoor *et al*. (2020) in their report stated that the potential for synergistic effects when combining these two protein sources.

Although several studies have explored the use of feather meal as a partial substitute for fish meal, despite the low cost of production, nutritional physiology and its immune advancing benefits there is limited research on the combined use of fermented chicken feather meal with fish meal as a dietary additive for broiler chicks. Therefore, this study was undertaken to evaluate the nutritional physiology of fermented chicken feather mixed with fish meal as a feed additive for healthy broiler chicks.

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°C for 5 minutes, followed by 35 cycles of denaturation, annealing, and elongation, with a final extension period at 72°C 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 with fish meal and 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

Body weights: The body weights of the experimented rats were checked and recorded weekly using electronic weighing balance (LXD200) and recorded as described in the work published by Nwobodo *et al.* (2018), Iheukwumere *et al*. (2025u).

Organ weights: The body weights of the experimented chicks were checked and recorded weekly using electronic weighing balance (LXD200) and recorded as described in the work published by Nwobodo *et al.* (2018), Iheukwumere *et al*. (2025v).

Hematological Indices: The blood samples collected from the broiler chicks were examined using Automated Hematology Analyzer (MIN DRAY BC – 360), and the variations in the red blood cells (RBCs), lymphocytes, monocytes, neutrophils, eosinophils and basophils were assessed and recorded as described in the work published by Agiang *et al.* (2017).

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 body weight of the chicks when feed with fermented chicken feather and fish meal revealed that there was a significant ($P<0.02$) increase in the body weight of the chicks compared to the control group and this was very pronounced at week six of feeding the chicks with the fermented feed supplement as shown in Table 5.
The result of the organ weight of the chicks after been feed with fermented supplement (chicken feather + fish meal) 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 6.

The feed conversion ratio and feed intake of the chicks in shown in table 1. The result revealed that during the first week, that FCR of the test group (2.471) was higher than the control group (2.143), during the second week the FCR of the control group was higher than the test group (3.217), and also in week three the FCR of the control group was also higher than the test group same as week four but during week 5 and 6 the FCR of the test group was higher than the control group, also the result revealed that weight and weight gain of the test group was higher than the control group and this indicates that the fermented feed supplement (chicken feather + fish meal) had a significant effect on the broiler chicks as shown in Table 7.

The blood indices of the chicks fed with the fermented feed supplement (chicken feather +fish meal) revealed that there was an increase in the counts of WBC, RBC, PLT, and in the percentage of monocyte, basophil and lymphocyte of the test group but reduced the number of the Neutrophil, Eosinophil amongst the test group compared to the control group as shown in Table 8.

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 fermenters

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 fermenters

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 fermenters

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: Body weights of the chicks

Week	Control Group	Test Group
1	168	192
2	376	423
3	660	746
4	974	1166
5	1220	1621
6	1442	2109

Table 6: Organ weight of the chicks

Organ	Control group	Test group
Liver (g)	7.40 ± 0.01	7.40 ± 0.01
Kidney (g)	0.52 ± 0.01	0.51 ± 0.01
Lungs (g)	1.31 ± 0.01	1.30 ± 0.01
Heart (g)	0.67 ± 0.01	0.67 ± 0.01

Table 7: Feed intake and feed conversion ratio among the chicks

Week	Control Group				Test Group			
	Feed (g)	Weight (g)	Weight gain (g)	FCR	Feed (g)	Weight (g)	Weight gain (g)	FCR
1	28	168	60	2.143	34	192	89	2.6176
2	62	376	208	3.355	69	423	231	3.3478
3	102	660	284	2.784	117	746	323	2.7607
4	146	947	287	1.966	158	1146	400	2.5316
5	194	1220	273	1.407	208	1621	475	2.2837
6	243	1442	222	0.914	268	2109	488	1.8209

Table 8: Hematological indices

Parameter	Control Group	Group fed with chicken Feather	Group fed with chicken feather and fish meal
WBC (X10^9L)	12. 88	18.75	19.20
RBC (X10^9L)	7.37	8.12	8.92
PLT (X10^9L)	825.00	945.00	947.00
Neu (%)	40.60	6.45	6.55
Eos (%)	4.75	0.10	0.10
Mon (%)	3.85	2.55	2.05
Bas (%)	0.10	0.10	0.10
Lym (%)	50.70	90.80	91.20

Discussion

Fermented feeds have been shown to reduce anti-nutritional factors, improve palatability, increase beneficial microflora in the gut, and enhance the bioavailability of nutrients and when applied to chicken feather, fermentation can improve its amino acid profile, reduce mycotoxin risks, and increase lactic acid production, which benefits gut health and pathogen resistance in poultry (Hur *et al*., 2014). Similarly, fermented fish meal can further enhance its nutritional value by partially hydrolyzing proteins into peptides and amino acids, making

them easier for broilers to digest and absorb (Mohammadi *et al*., 2021). This present study focuses on the assessment of fermented chicken feather mixed with fish meal as a chicken additive for healthy broiler chicks. 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 of fermented chicken feather showed an increased, weight gain, and this corroborated the findings of many researchers (Baluogu *et al*., 2017; Onunkwo and Ekine, 2020; Yang *et al*., 2020) who evaluated the nutritional quality of fermented chicken feather. Similar observations were found when the chicks were fed fermented fish meal. Compared to the combination of both fermented meals when fed to the chicks, the results revealed that there was a pronounced increase in the body weight gain, organ weight and immune response and these findings corroborated with the findings of many researchers (Sugiharto and Ranjikar, 2019; Zhang *et al*., 2022 and Hong *et al*., 2025) who evaluated the effect of fermented feed meals on the growth performance of broiler chicks and this could be attributed to lactic acid bacteria present in the feed samples.

Conclusion

This study has shown that *Lactobacillus acidophilus*-fermented chicken feather and bean chaff enhances gut health, promotes growth, and improves productivity in chicks. The fermented product improves body weights, feed intake, and hematological indices, offering a potential prebiotic solution for the poultry industry.

Acknowledgment

We are grateful to all our study participants who join the study voluntarily. We are grateful to ZAHARM Analytical and Research Laboratory, Amawbia, Awka Anambra State, Nigeria for providing enabling environment, resources and techniques for this study. We really salute their wonderful efforts.

Conflict of interests: The authors declare that they have no conflict of interests.

Funding: This research did not receive specific grant from any funding agencies.

References

Amadi, R.E., Iheukwumere, I.H. and Unaeze, B.C. (2017). Effects Of Crude Alkaloid Extracted From Ocimum Gratissimum On The Activity Of Ciprofloxacin Against Salmonella Enterica Serovar Typhi. *Advances in Life Science and Technology* 58.

Anahtar, M. N., Byrne, E. H., Doherty, K. E., Bowman, B. A., Yamamoto, H. S., Soumillon, M., ... and Kwon, D. S. (2018). Cervicovaginal bacteria are a major modulator of host inflammatory responses in the female genital tract. *Immunity*, *42*(5), 965-976. https://doi.org/10.1016/j.immuni.2015.04.019

Anjum, N., Maqsood, S., Masud, T., Ahmad, A., Sohail, A., & Momin, A. (2014). Lactobacillus acidophilus: characterization of the species and application in food production. *Critical reviews in food science and nutrition*, *54*(9), 1241-1251.

Balogu, T. V., Ibrahim, H., & Balogu, D. O. (2017). Nutritionally improved corn mill waste (chaff) with microbial protein: An economic alternative for poultry feed. *Advances in Applied Sciences*, *2*(2), 18-22.

Bell, V., Ferrão, J., & Fernandes, T. (2017). Nutritional guidelines and fermented food frameworks. *Foods*, *6*(8), 65. https://doi.org/10.3390/foods6080065

Brandelli, A., Sala, L. and Kalil, S. J. (2015). Microbial enzymes for bioconversion of poultry waste into added-value products. *Food Research International*, 73, 3–12.

Cabel, M. C., Goodwin, T. L., & Waldroup, P. W. (1988). Feather meal as a nonspecific nitrogen source for abdominal fat reduction in broilers during the finishing period. *Poultry Science*, *67*(2), 300-306.

Cai, J., Chen, J. and Zhang, J. (2020). Enhancing the nutritional value of feed ingredients for poultry: Advances and future directions. *Animal Feed Science and Technology*, 265, 114457.

Cai, Y., Li, Y., Zhang, Y., & Wang, Y. (2019). The role of *Lactobacillus* in immune regulation: Current status and perspectives. *Frontiers in Immunology*, *10*, 1804. https://doi.org/10.3389/fimmu.2019.01804

Celik, O. F., Con, A. H., Saygin, H., Şahin, N., & Temiz, H. (2021). Isolation and identification of lactobacilli from traditional yogurts as potential starter cultures. *LWT*, *148*, 111774.

Chachaj, R., Sembratowicz, I., Krauze, M., & Ognik, K. (2019). The effect of partial replacement of soybean meal with fermented soybean meal on chicken performance and immune status. *Journal of Animal and Feed Sciences*, *28*(3), 263-271.

Chen, M., Sun, Q., & Giovannucci, E. (2021). Dairy consumption and risk of type 2 diabetes: The role of fermented dairy products. *American Journal of Clinical Nutrition*, *113*(5), 1100–1111. https://doi.org/10.1093/ajcn/nqaa397

Chude,C.O., Iheukwumere, I.H., Iheukwumere, C.M., Nwaolisa,C.N., Egbuna, C.,Nwakoby, N.E.and Egbe, P.A. (2020). Cidal activity of proteins secreted by *Bacillus thuringensis* against *Ascaris lumbricoides. International Journal of Research Publications* 49(1): 1033 – 1045.

Cristofori, F., Dargenio, V. N., Dargenio, C., Miniello, V. L., Barone, M., & Francavilla, R. (2021). Anti-inflammatory and immunomodulatory effects of probiotics in gut inflammation: A door to the future. *Frontiers in Immunology*, *12*, 578386. https://doi.org/10.3389/fimmu.2021.578386

Dim, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Ugwu, C. H., Ike, V. E., Ezendianefo, . J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., Oduenyi, P. M., & Ochibulu, S. C. (2025a). Multiple Antibiotic Resistance Bacterial Strains in Frozen Meat Sold at Abagana, Anambra State: A Public Health Concern. *IPS Journal of Applied Microbiology and Biotechnology*, *4*(3), 181–186. https://doi.org/10.54117/ijamb.v4i3.75

Dim, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Ugwu, C. H., Ike, V. E., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., Oduenyi, P. M., & Ochibulu, S. C. (2025b). The Burden of Antibiotic Resistance: Evaluating the Impact of Multiple Antibiotic-Resistant Enteric Bacteria in Academic Environments. *IPS Interdisciplinary Journal of Biological Sciences*, *4*(4), 144–149. https://doi.org/10.54117/iijbs.v4i4.78

Dim, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Ugwu, C. H., Ike, V. E., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., Oduenyi, P. M., & Ochibulu, S. C. (2025c). Antimicrobial resistance in aquaculture: evaluating pseudomonas aeruginosa from fish ponds. *IPS Intelligentsia Multidisciplinary Journal*, *4*(1), 32–36. https://doi.org/10.54117/iimj.v4i1.10

Dimidi, E., Cox, S. R., Rossi, M., & Whelan, K. (2019). Fermented foods: Definitions and characteristics, impact on the gut microbiota and effects on gastrointestinal health and disease. *Nutrients*, *11*(8), 1806. https://doi.org/10.3390/nu11081806

Divisekera, D. M. W. D., Samarasekera, J. K. R. R., Hettiarachchi, C., Gooneratne, J., Choudhary, M. I., & Gopalakrishnan, S. (2019). Isolation and identification of lactic acid bacteria with probiotic potential from fermented flour of selected banana varieties grown in Sri Lanka. *Journal of the National Science Foundation of Sri Lanka*, *47*(1).

Egbe, P. A., Umeaku, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Onwuasoanya, U. F., Ezenwata, I. S., Afulukwe, S. C., Ike, V. E., & Ezeumeh, E. N. (2025a). Antibiotic Susceptibility of Helicobacter pylori Isolates from Patients at Nnewi Teaching Hospital, Anambra State. *IPS Journal of Basic and Clinical Medicine*, 2(2), 51–57. https://doi.org/10.54117/ijbcm.v2i2.11.

Egbe, P. A., Umeaku, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Onwuasoanya, U. F., Ezenwata, I. S., Afulukwe, S. C., Ike, V. E., Ezeumeh, E. N., & Egbuna, C. (2025b). Helicobacter pylori Inhibition by Medicinal Plant Extracts: An In Vitro Assessment. IPS Journal of Drug Discovery Research and Reviews, 3(1), 32–37. https://doi.org/10.54117/ijddrr.v3i1.28.

Egbe, P. A., Umeaku, C. N., Iheukwumere, I. H., Iheukwumere, C. M., Onwuasoanya, U. F., Ezenwata, I. S., Afulukwe, S. C., Ike, V. E., & Ezeumeh, E. N. (2025c). Medicinal Plant Extracts Enhance Conventional Antibiotic Activity against Helicobacter pylori: An In Vitro Assessment. IPS Interdisciplinary Journal of Biological Sciences, 4(2), 93–99. https://doi.org/10.54117/iijbs.v4i2.51.

Ejike, C.E., Iheukwumere, I.H. and Armadi, R.E. (2017). Susceptibility of Escherichia coli Isolated from Oligospermia Patient to *Gongronema latifolium* leaves extract. J. *Biol. Agriculture. Healthcare* 7(14).

Ekechukwu, C. C., Umeh, S. O., Iheukwumere, I. H., & Iheukwumere, C. M. (2025a). Bacterial Loads of Smoked Fish and Chicken: Role of pH and Moisture Content. *IPS Applied Journal of Nutrition, Food and Metabolism Science*, 3(1), 44–49. https://doi.org/10.54117/iajnfms.v3i1.102.

Ekechukwu, C. C., Umeh, S. O., Iheukwumere, I. H., & Iheukwumere, C. M. (2025b). Biological Inhibition of Pathogenic Bacteria Isolated from Smoked Fish and Chicken: An In Vitro Study. IPS Interdisciplinary Journal of Biological Sciences, 4(2), 85–92. https://doi.org/10.54117/iijbs.v4i2.50.

Ekechukwu, C. C., Umeh, S. O., Iheukwumere, I. H., & Iheukwumere, C. M. (2025c). Prophylactic Potential of the Most Potent Synergistic Biological Agent against Bacterial Infections from Smoked Fish and Chicken. IPS Journal of Applied Microbiology and Biotechnology, 4(2), 153–160. https://doi.org/10.54117/ijamb.v4i2.57.

Ekesiobi, A. O., Iheukwumere, C. M., Iheukwumere, I. H., Ejike, C. E., Ilechukwu, C. C., Ike, V. E., Okereke, F. O., & Ochibulu, S. C. (2025). Hyping the Inhibitory Activity of Xylopia aethiopica against Vibrio cholerae using Azithromycin. IPS Journal of Basic and Clinical Medicine, 2(3), 93–98. https://doi.org/10.54117/ijbcm.v2i3.16

Ezedianafo, J. N., Iheukwumere, I. H., Iheukwumere, C. M., Okolo, O., Nwike, I., & Ubajekwe, C. C. (2025a). *Musca domestica*: A vector of multidrug-resistant enteric bacteria. *Journal of Veterinary, Allied, and One Health Sciences, 1*(2), 30–38. https://doi.org/10.54117/3vwg0p36

Ezedianafo, J. N., Iheukwumere, I. H., Iheukwumere, C. M., Okolo, O., Nwike, I., & Ubajekwe, C. C. (2025b). Occurrences of meropenem- and imipenem-resistant *Klebsiella pneumoniae* in *Musca domestica* in hospital landfills. *African Journal of Applied Research & Sustainable Development*, *1*(2), 25–35. https://doi.org/10.54117/wjmnyv91

Ezendianefor, J. N., Iheukwumere, I. H., Iheukwumere, C. M., Okolo, O., Nwike, I., & Ubajekwe, C. C. (2025c). Multiple antibiotic resistance indices of enteric bacteria isolated from *Musca domestica*. *Journal of Public Health, Policy, and Society*, *1*(2), 29–37. https://doi.org/10.54117/k8r78723

Ezendianefor, J. N., Iheukwumere, I. H., Iheukwumere, C. M., Okolo, O., Nwike, I., & Ubajekwe, C. C. (2025d). *Klebsiella pneumoniae* isolated from *Musca domestica*: Antibiotic susceptibility and resistance patterns. *Journal of Veterinary, Allied, and One Health Sciences, 1*(2), 39–47. https://doi.org/10.54117/vy6y8f94

Ezendianefor, J. N., Iheukwumere, I. H., Iheukwumere, C. M., Okolo, O., Nwike, I., & Ubajekwe, C. C. (2025e). *Musca domestica* as vectors of pathogenic enteric bacteria: A public health concern. *African Journal of Applied Research & Sustainable Development*, *1*(2), 36–45. https://doi.org/10.54117/s671mk28

Frias, J., Peñas, E., & Martínez-Villaluenga, C. (2017). Fermented foods in health promotion and disease prevention. In V. R. Preedy & R. R. Watson (Eds.), *Fermented Foods in Health and Disease Prevention* (pp. 3–20). Academic Press.

Gao, J., Zhang, H. J., Wu, S. G., Yu, S. H., Yoon, I., Quigley, J., Gao, Y. P. and Qi, G. H. (2017). Effects of yeast culture in broiler diets on performance and immunomodulatory functions. *Poultry Science*, 96(3), 834–847.

Guo, J., Xu, W., Hu, D., Gao, Y., & Xu, J. (2012). Study on the biodegradation of waste feathers and the keratinase activity of *Streptomyces fradiae* var. k11. *African Journal of Biotechnology*, *11*(2), 362–367. https://doi.org/10.5897/AJB11.2161

Guo, Q., Goldenberg, J. Z., Humphrey, C., El Dib, R., Johnston, B. C., & Lo, C. K. F. (2020). Probiotics for the prevention of pediatric antibiotic-associated diarrhea. *Cochrane Database of Systematic Reviews*, *4*(4), CD004827. https://doi.org/10.1002/14651858.CD004827.pub5

Guo, S., Zhang, Y., Cheng, Q., Xv, J., Hou, Y., Wu, X., Du, E., & Ding, B. (2020). Partial Substitution of Fermented Soybean Meal for Soybean Meal Influences the Carcass Traits and Meat Quality of Broiler Chickens. *Animals*, *10*(2), 225. https://doi.org/10.3390/ani10020225

Gupta, R. and Ramnani, P. (2006). Microbial keratinases and their prospective applications: An overview. *Applied Microbiology and Biotechnology*, 70, 21–33.

Gupta, S., & Cheng, K. M. (2015). Fish meal replacement in poultry diets: A review. *World's Poultry Science Journal, 71*(4), 653–666. https://doi.org/10.1017/S0043933915002423

Hill, C., Guarner, F., Reid, G., Gibson, G. R., Merenstein, D. J., Pot, B., ... and Sanders, M. E. (2014). Expert consensus document: The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. *Nature Reviews Gastroenterology and Hepatology*, *11*(8), 506-514. https://doi.org/10.1038/nrgastro.2014.66

Hossain, H., Nuradji, H., Miah, M. Y., Islam, M. N., & Siddiqui, M. S. I. (2025). Impact of synbiotic on growth performance, histo-architectural modulation of lymphoid organ, hematology, blood biochemistry and humoral immune response in naked neck chicken. *Tropical Animal Health and Production*, *57*(1), 4.

Hur, S. J., Lee, S. Y., Kim, Y. C., Choi, I., & Kim, G. B. (2014). Effect of fermentation on the antioxidant activity in plant-based foods. *Food Chemistry*, *160*, 346–356. https://doi.org/10.1016/j.foodchem.2014.03.112

Husnain, A., Anwar, U., Fatima, A., Mustafa, R., Farooq, U., Abbas, W., Khalid, M. F., Ashraf, M., & Aziz ur Rahman, M. (2025). Effects of replacement of soybean meal with fermented soybean meal on growth performance, nutrient digestibility and carcass characteristics in broiler. *Livestock Science*, *299*, 105779. https://doi.org/10.1016/j.livsci.2025.105779

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025a). Bacterial symbionts of *Rhynchophorus phoenicis*: Modulation of rat lymphocyte function and immunity. *Journal of Tropical Medicine and Public Health Solutions, 1*(2), 55–63. https://doi.org/10.54117/jtmphs.v1i2.36

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025b). Multidrug-resistant *Klebsiella pneumoniae* in *Musca domestica*: A potential public health threat. *Journal of Tropical Medicine and Public Health Solutions, 1*(2), 46–54. https://doi.org/10.54117/jtmphs.v1i2.35

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025c). Termite-derived antimicrobials: A novel approach to control *Bacillus cereus* in food products. *International Journal of Global Trends and Research, 1*(2), 45–57. https://doi.org/10.54117/2mgwn270

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025d). Bacterial diversity in insect guts and their potential applications in industry. *International Journal of Global Trends and Research, 1*(2), 36–44. https://doi.org/10.54117/2k0d9t18

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025e). Bioactive compounds from *Macrotermes*: A novel approach to combat multidrug resistant *Klebsiella pneumoniae* from *Musca domestica* in hospital

landfills. *IPS Journal of Biotechnology and Applied Biochemistry*, *1*(2), 82–92. https://doi.org/10.54117/ijbab.v1i2.111

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025f). Assessment of blood indices in rats supplemented with Macrotermes-derived nutrient-enhanced bacteria. *IPS Journal of Basic and Clinical Medicine*, *2*(4), 143–151. https://doi.org/10.54117/ijbcm.v2i4.39

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025g). Exploring the potential of termite gut bacteria as growth promoters and organ function enhancers in albino Wistar rats. *Health Science Research International*, *1*(2), 43–52. https://doi.org/10.54117/hsri.v1i2.38

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025h). Assessment of hematological parameters in albino Wistar rats fed with *Rhynchophorus phoenicis* larvae enriched with autochthonous bacteria. *Health Science Research International*, *1*(2), 34–42. https://doi.org/10.54117/hsri.v1i2.37

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025i). Entomopathogenic bacteria-mediated management of *Delia radicum*: A step towards eco-friendly pest control. *Journal of Agriculture, Food Technology and Sustainability*, *2*(2), 112–121. https://doi.org/10.54117/jafts.v2i2.110

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025j). Antimicrobial activity of Macrotermes-derived eluates against multidrug resistant Pseudomonas species: Implications for aquaculture disease management. *Journal of Agriculture, Food Technology and Sustainability*, *2*(2), 102–111. https://doi.org/10.54117/jafts.v2i2.109

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025k). Exploring the potential of entomopathogenic bacteria for sustainable management of *Sitophilus zeamais* in maize storage systems. *IPS Journal of Plant, Animal, and Environmental Sciences*, *1*(1), 11–20. https://doi.org/10.54117/ijpae.v1i1.108

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025l). Biological control of *Acanthoscelides obteus* using entomopathogenic bacteria. *IPS Journal of Plant, Animal, and Environmental Sciences*, *1*(1), 1–10. https://doi.org/10.54117/ijpae.v1i1.107

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025m). Modulation of phagocytic index in albino Wistar rats via bacterial symbionts from *Rhynchophorus phoenicis* larvae. *African Journal of Nutrition and Applied Research*, *1*(2), 27–36. https://doi.org/10.54117/fm3vgt16

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025n). Bacterial symbionts of insect larvae: A novel approach to improving micronutrient content. *African Journal of Nutrition and Applied Research*, *1*(2), 27–36. https://doi.org/10.54117/960k2266

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025o). Unlocking the potential of termite gut microbiome: Enhancing nutritional value through bacterial symbionts. *IPS Journal of Nutrition and Food Science*, *5*(1), 636–645. https://doi.org/10.54117/ae6gj081

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025p). Enhancing nutritional parameters with bacterial symbionts from Macrotermes species: A potential frontier in nutritional biotechnology. *IPS Journal of Nutrition and Food Science*, *5*(1), 625–635. https://doi.org/10.54117/a2b7jb52

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025q). Bacterial symbionts of Macrotermes species: Assessing their impact on phagocytic indices of albino Wistar rats. *IPS Interdisciplinary Journal of Biological Sciences*, *5*(1), 187–196. https://doi.org/10.54117/iijbs.v5i1.106

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025r). Bacterial symbionts of insects: Exploring their role in insect nutritional composition. *IPS Interdisciplinary Journal of Biological Sciences*, *5*(1), 177–186. https://doi.org/10.54117/iijbs.v5i1.105

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025s). Augmenting rat lymphocyte function by bacterial symbiont of Macrotermes species. *IPS Journal of Applied Microbiology and Biotechnology*, *5*(1), 281–290. https://doi.org/10.54117/ijamb.v5i1.104

Idigo, M. A., Iheukwumere, I. H., Iheukwumere, C. M., Nnaeze, B. C., Akulue, C. J., Nwakoby, N. E., Ezendianefor, J. N., Ike, V. E., Nnaedozie, A. O., Ezekwueche, S. N., Anagor, I. S., Aniekwe, C. C., Ezeoke, F. C., Okereke, F. O., & Ochibulu, S. C. (2025t). Antimicrobial peptides from insects: A study on their efficacy against pathogens. *IPS Journal of Applied Microbiology and Biotechnology*, *5*(1), 271–280. https://doi.org/10.54117/ijamb.v5i1.103

Iheukwumere, C. M., & Iheukwumere, I. H. (2022a). Nutritive and Antinutrient Values of Soybean Condiments Produced from Indigenous Fermenters. *IPS Applied Journal of Nutrition, Food and Metabolism Science*, 1(1): 1-5. https://doi.org/10.54117/iajnfms.v1i1.8

Iheukwumere, C. M., & Iheukwumere, I. H. (2022e). Hematological indices and sensory quality of fermented soybean condiments. *World Journal of Advanced Research and Reviews*, 14(2), 435-42

Iheukwumere, C. M., Ekesiobi, A. O., Iheukwumere, I. H., Ejike, C. E., Ilechukwu, C. C., Dim, C. N., & Ochibulu, S. C. (2025g). Dual Approach Therapy: Assessing Xylopia aethiopica and Ciprofloxacin Synergy against Salmonella enterica Serovar Typhi. *IPS Intelligentsia Multidisciplinary Journal*, *4*(1), 27–31. https://doi.org/10.54117/iimj.v4i1.9.

Iheukwumere, C. M., Ekesiobi, A. O., Iheukwumere, I. H., Ejike, C. E., Ilechukwu, C. C., Dim, C. N., Ochibulu, S. C., Unegbu, C. C., & Egbuna, C. (2025h). Food Safety Implications: Assessing the Potential of Desmodium velutinum Leaves Extracts to Control the Most Predominant Fungal Contamination in Ready-To-Eat Fried Chicken. *IPS Journal of Nutrition and Food Science*, *4*(3), 494–500. https://doi.org/10.54117/ijnfs.v4i3.111

Iheukwumere, C. M., Iheukwumere, I. H., Okoli, U. O., & Ugwu, C. H. (2023a). Immunological Impact of Fermented Soybean Condiments Produced from Indigenous Fermenters. *Journal of Advances in Microbiology* 23(10): 27-37

Iheukwumere, C. M., Iheukwumere, I. H., Ugwu, C. H., & Okoli, U. O. (2023b). Toxicity of Prepared Fermented Soybean Condiments from Indigenious Fermenters. *Journal of Advances in Microbiology* 23(10): 38 – 51.

Iheukwumere, C. M., Umeaku, C. N., Chukwura, E. N., & Iheukwumere, I. H. (2022f). Characterization of the indigenous fermenters for the production of fermented condiments from soybean seeds. *World Journal of Advanced Research and Reviews*, *14*(2), 423-434.

Iheukwumere, I. H., & Ejike, C. E. (2017b). Comparative study of the inhibitory activities of Ocimum gratissimum and Nepeta cataria against Salmonella enterica serovar Typhi and their larvicidal effect against Anopheles gambiae. *African Journal of Education, Science and Technology (AJEST)*, *3*(4), 16-24

Iheukwumere, I. H., Ajeh, J. C., Iheukwumere, C. M., Ike, V. E., Obianom, A. O., Ihenatuoha, U. A. ., Igboanugo, E. U., Onwuasoanya, U. F., Okereke, F. O., Nnadozie, C. H., Agbaugo, C. F., Nwike, M. I.,

Nwakoby, N. E., & Ilechukwu, C. C. (2025c). Exploring the Phytochemical and Antimicrobial Properties of Fruit Vinegar: A Study on Phoenix Dactylifera and Malus Sylvestris. *IPS Journal of Applied Microbiology and Biotechnology*, 4(1), 115–122. https://doi.org/10.54117/ijamb.v4i1.48

Iheukwumere, I. H., Ajeh, J. C., Iheukwumere, C. M., Ike, V. E., Obianom, A. O., Ihenatuoha, U. A., Igboanugo, E. U., Onwuasoanya, U. F., Okereke, F. O., Nnadozie, C. H., Agbaugo, C. F., Nwike, M. I., Nwakoby, N. E., & Ilechukwu, C. C. (2025d). Microbial Quality and Sensory Assessment of Vinegar from Date Palm and Apple Fruits: Implications for Consumer Preference. IPS Journal of Nutrition and Food Science, 4(2), 410–417. https://doi.org/10.54117/ijnfs.v4i2.100.

Iheukwumere, I. H., Ajeh, J. C., Iheukwumere, C. M., Ike, V. E., Obianom, A. O., Ihenatuoha, U. A., Igboanugo, E. U., Onwuasoanya, U. F., Okereke, F. O., Nnadozie, C. H., Nwike, M. I., Nwakoby, N. E., & Ilechukwu, C. C. (2025f). Safety Evaluation of Vinegar from Phoenix Dactylifera and Malus Sylvestris: Toxicity and Acetic Acid Content. IPS Journal of Applied Microbiology and Biotechnology, 4(1), 123–131. https://doi.org/10.54117/ijamb.v4i1.49

Iheukwumere, I. H., Ajeh, J. C., Iheukwumere, C. M., Ike, V. E., Obianom, A. O., Ihenatuoha, U. A. ., Igboanugo, E. U., Onwuasoanya, U. F., Okereke, F. O., Nnadozie, C. H., Agbaugo, C. F., Nwike, M. I., Nwakoby, N. E., & Ilechukwu, C. C. (2025k). Exploring the Phytochemical and Antimicrobial Properties of Fruit Vinegar: A Study on Phoenix Dactylifera and Malus Sylvestris. *IPS Journal of Applied Microbiology and Biotechnology*, 4(1), 115–122. https://doi.org/10.54117/ijamb.v4i1.48

Iheukwumere, I. H., Amadi, E. R., & Chude, C. (2018b). Synergistic Effects of Probiotics and Autogenous Bacterin Against Inositol Negative Motile Salmonella Species. *Journal of Biology, Agriculture and Healthcare* 8(6).

Iheukwumere, I. H., Amadi, R. E., Unaeze, B. C., & Campus, N. (2017c). Enterotoxigenicity Profile of Salmonella Enterica Serovar Typhimurium in Suckling Albino Mice. Journal of Natural Sciences Research 7(14).

Iheukwumere, I. H., Chukwura, E. I., & Chude, C. (2018c). In vivo activities of some selected antimicrobial agents against enteric bacteria isolated from chicken feeds on broiler layers. *Journal of Biology, Agriculture and Healthcare*, *8*(6).

Iheukwumere, I. H., Ejike, C. E., & Okeke, C. E. (2017d). A trial to prevent sorbitol negative Escherichia coli infections in chicks using autogenous bacteria and probiotics. *Journal of Natural Sciences Research*, *7*, 56-63.

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025m). *Lactobacillus* fermentation of chicken feather: Impact on structural development and immune system of albino Wistar rats. *IPS Applied Journal of Nutrition, Food and Metabolism Science*, *3*(2), 75–83. https://doi.org/10.54117/qabcj082

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025n). Evaluation of *Lactobacillus* fermented chicken feather meal on blood lipoproteins and lymphocyte count in rats. *IPS Journal of Nutrition and Food Science*, *4*(4), 569–577. https://doi.org/10.54117/012d8612

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025o). Exploring the impact of *Lactobacillus*-fermented chicken feather on organ weights and functions in albino Wistar rats. *IPS Journal of Toxicology*, *3*(3), 68–75. https://doi.org/10.54117/zc1h5865

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025p). Corollary of Lactobacillus Fermented Chicken Feather on Organ-Weight and Leukocyte Indices of Broiler Chicks. *IPS Intelligentsia Multidisciplinary Journal*, *4*(1): 46-53. https://doi.org/10.54117/iimj.v4i1.12

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025q). Fermented Chicken Feather Meal as a Potential Feed Supplement: Effects on Body Weight and Immune Function. *IPS Intelligentsia Multidisciplinary Journal*, *4*(1), 37–45. https://doi.org/10.54117/iimj.v4i1.11

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025r). Corollary of Lactobacillus Fermented Chicken Feather on Growth Performance of Rats. *IPS Journal of Biotechnology and Applied Biochemistry*, *1*(2), 57–65. https://doi.org/10.54117/ijbab.v1i2.85

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025s). Corollary of Lactobacillus Fermented Chicken Feather on Growth Performance of Rats. *IPS Journal of Biotechnology and Applied Biochemistry*, *1*(2), 57–65. https://doi.org/10.54117/ijbab.v1i2.85

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025t). Fermented Chicken Feather as a Sustainable Feed Ingredient: Effects on Broiler Chick Health and Growth. *IPS Interdisciplinary Journal of Biological Sciences*, *4*(4), 157–165. https://doi.org/10.54117/iijbs.v4i4.84

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025u). Assessment of Fermented Corn Mixed with Fish Meal as a Chicken Additive for Healthy Broiler Chicks. *Journal of Agriculture, Food Technology and Sustainability*, *2*(1), 60–68. https://doi.org/10.54117/jafts.v2i1.82

Iheukwumere, I. H., Iheukwumere, C. M., Idigo, M. A., & Ezekwueche, S. N. (2025v). Evaluation of Fermented Corn Residue as a Growth Promoter in Broiler Chicken Diets. *Journal of Agriculture, Food Technology and Sustainability*, *2*(1), 69–77. https://doi.org/10.54117/jafts.v2i1.83

Iheukwumere, I. H., Iheukwumere, C. M., Obianom, A. O., Nnadozie, C. H., Okereke, F. O., Onwuasoanya, U. F., … Ihenatuoha, U. A. (2025a). Cross-Sectional Study of Different Strains of Bacillus cereus among Pap Sold in Major Towns in Ihiala LGA, Anambra State. IPS Journal of Public Health, 5(2), 199–204. https://doi.org/10.54117/ijph.v5i2.39.

Iheukwumere, I. H., Iheukwumere, C. M., Obianom, A. O., Nnadozie, C. H., Okereke, F. O., Onwuasoanya, U. F., … Destiny, E. C. (2025b). Cross-Sectional Study of Major Strains of Salmonella enterica Subspecies Enterica Serovar Typhi among Borehole Used in Uli Community. IPS Journal of Public Health, 5(2), 205–210. https://doi.org/10.54117/ijph.v5i2.40.

Iheukwumere, I. H., Iheukwumere, C. M., Obianom, A. O., Nnadozie, C. H., Okereke, F. O., Onwuasoanya, U. F., Udeagbara, O. E., Unaeze, B. C., Obiefuna, O. H., Ike, V. E., Onyemekara, N. N., & Ihenatuoha, U. A. (2025e). Quotidian of Substantial Strain of Shigella dysenteriae among Ready To-Eat Fruit Salad Sold in Uli Community. Journal of Pollution Monitoring, Evaluation Studies and Control, 4(1), 95–99. https://doi.org/10.54117/jpmesc.v4i1.17

Iheukwumere, I. H., Iheukwumere, C. M., Obianom, A. O., Nnadozie, C. H., Okereke, F. O., Onwuasoanya, U. F., … Ihenatuoha, U. A. (2025i). Cross-Sectional Study of Different Strains of Bacillus cereus among Pap Sold in Major Towns in Ihiala LGA, Anambra State. IPS Journal of Public Health, 5(2), 199–204. https://doi.org/10.54117/ijph.v5i2.39.

Iheukwumere, I. H., Iheukwumere, C. M., Obianom, A. O., Nnadozie, C. H., Okereke, F. O., Onwuasoanya, U. F., … Destiny, E. C. (2025j). Cross-Sectional Study of Major Strains of Salmonella enterica Subspecies Enterica Serovar Typhi among Borehole Used in Uli Community. IPS Journal of Public Health, 5(2), 205–210. https://doi.org/10.54117/ijph.v5i2.40.

Iheukwumere, I. H., Iheukwumere, M. C., & Nwakoby, N. E. (2022d). Sequential Pathogenicity Study of SOR+ and SOR-Escherichia coli Isolated from Roasted Meat. *IPS Intelligentsia Multidisciplinary Journal*, *1*(1), 1-11.

Iheukwumere, I. H., Obi, P. C. and Unaeze, B. C. (2017a). A trial to prevent *Vibrio cholerae* in albino mice using autogenous bacterin. *Advances in Life Science and Technology* 58:34–42

Iheukwumere, I. H., Uneze, B. C., & Ejike, C. E. (2017e). Efficacy of some selected antimicrobial substances in prevention of enteric bacterial infection in broiler chicks. *J. Biol. Agriculture. Healthcare*, *7*, 58-66.

Iheukwumere, I.H. , Iheukwumere, C.M. , Nnadozie, H. C. ,Unaeze, C.B. , Obiefuna, O.H. Obianom, A.O. and Ejike, C. E. (2024). Hematotoxicological and mosquito larvicidal studies of crystal proteins secreted by Bacillus thuringiensis and Bacillus sphaericus. *Tropical Journal of Applied Natural Sciences* 2(2): 61 – 92.

Iheukwumere, I.H. and Iheukwumere, M.C. (2022c). Streptococcus suis in Pigs and Environs: A Cross-sectional Study. IPS Journal of Public Health, 1(2), 9-12. https://doi.org/10.54117/ijph.v1i2.4.

Iheukwumere, I.H. and Iheukwumere, M.C. (2022g). Cross-sectional Study of Multiple Antibiotic-resistant Streptococcus suis in Pigs and Environments. IPS Interdisciplinary Journal of Biological Sciences, 1(1), 19–21. https://doi.org/10.54117/iijbs.v1i1.4

Iheukwumere, I.H., Dimejesi, S.A.,Iheukwumere, C.M., Chude, C.O., Nwaolisa, C.N.,Ukoha, C.C., Nwakoby,N.E., Egbuna, C. and Egbe, P.A. (2020b) Diversity and molecular characterization of keratinophilic fungi from soil samples. *International Journal of Research Publication* 50(1); 1047 -1062.

Iheukwumere, I.H., Iheukwumere, M.C. and Nwakoby, N.E. (2022b). Synergistic Effects of Probiotics and Autogenous Bacterin against Salmonella enterica Serovar Typhimurium Strain U288. IPS Journal of Nutrition and Food Science, 1(1), 1–5. https://doi.org/10.54117/ijnfs.v1i1.3.

Iheukwumere, I.H., Nwike, M. I., Iheukwumere, C.M., Ike, V.E., Obianom, A.O., Ihenatuoha, U.A., Igboanugo, E.U., Ekesiobi, A.O., Okereke, F.O., Obiefuna, O. H. Nnadozie, C.H., Agbaugo, C.F., Oduoye, O.T., Nwakoby, N.E., Ilechukwu, C. C.,, Ochibulu, S. C. and Ejike, C. E.

(2025l). Extraction and Elucidation of Antibiotics from the Mycelia of Aspergillus niger Isolated from Poultry Farm against Enteric Bacterial Pathogens. *IPS Journal of Advanced and Applied Biochemistry*, 1(1), 1–10. https://doi.org/10.54117/ijaab.v1i1.58.

Iheukwumere,I.H., Iheukwumere,C.M., Chude, C.O., Nwaolisa,C.N. and Egbe, P.A. (2020a). Comparative study of different clinical samples used for the diagnosis of staphylococcal systemic infections in appearent healthy students. *International Journal of Research Publications* 49(1): 1 – 10

Ike, V. E., Iheukwumere, I. H., Iheukwumere, C. M., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., & Ochibulu, S. C. (2025a). Prevalence of Bacillus cereus in Powdered Soybean Sold in Uli Community, Anambra State: A Cross-Sectional Study. *IPS Journal of Basic and Clinical Medicine*, *2*(3), 108–114. https://doi.org/10.54117/ijbcm.v2i3.18

Ike, V. E., Iheukwumere, I. H., Iheukwumere, C. M., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., & Ochibulu, S. C. (2025b). *Bacillus cereus in Uli's cornflour: A prevalence study*. *IPS Journal of Nutrition and Food Science*, *4*(3), 544–548. https://doi.org/10.54117/8btte840

Ike, V. E., Iheukwumere, I. H., Iheukwumere, C. M., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., & Ochibulu, S. C. (2025c). Pathogenic Profile Analysis: In Vitro Screening of Enteric Bacteria from University Dusters. *IPS Journal of Applied Microbiology and Biotechnology*, *4*(3), 187–191. https://doi.org/10.54117/ijamb.v4i3.76

Ike, V. E., Iheukwumere, I. H., Iheukwumere, C. M., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., & Ochibulu, S. C. (2025d). Frozen Fish Pathogens: Antimicrobial Resistance and Public Health Implications. *IPS Interdisciplinary Journal of Biological Sciences*, *4*(4), 138–143. https://doi.org/10.54117/iijbs.v4i4.77

Ike, V. E., Iheukwumere, I. H., Iheukwumere, C. M., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., & Ochibulu, S. C. (2025e). Stream water quality assessment: Antibiotic resistance of Lac-positive enteric bacterial isolates. *Journal of Pollution Monitoring, Evaluation Studies and Control*, *4*(2), 120–125. https://doi.org/10.54117/jpmesc.v4i2.21.2025

Ke, K., Sun, Y., He, T., Liu, W., Wen, Y., Liu, S., ... & Gao, X. (2024). Effects of feather hydrolysates generated by probiotic Bacillus licheniformis WHU on gut microbiota of broiler and common carp. *Journal of Microbiology*, *62*(6), 473-487.

Khan, M. Z., Bano, N. and Ali, A. (2023). Role of micronutrients in poultry health: A review. *Poultry Science*, 102(4), 101267.

Kim, J., Lee, H., & Kim, Y. (2018). Effects of fermented milk products on cholesterol and blood pressure: A review of clinical trials. *Journal of Dairy Science*, *101*(4), 2724–2741. https://doi.org/10.3168/jds.2017-13708

Kim, S. K., Kim, T. H., Lee, S. K., Chang, K. H., Cho, S. J., Lee, K. W., & An, B. K. (2016). The Use of Fermented Soybean Meals during Early Phase Affects Subsequent Growth and Physiological Response in Broiler Chicks. *Asian-Australasian Journal of Animal Sciences*, *29*(9), 1287. https://doi.org/10.5713/ajas.15.0653

Manasseh, C.O., Logan, C.S.P., Ikeyi, A.P., Ede, K.K., Iheukwumere, I.H., Iheukwumere, C.M. and Ejike, C.E. (2025). Investigating the Effects of the Covid-19 Pandemic and Climate Risks on Trade Balance in Emerging Markets. *The Nigerian Health Journal* 25(2): 1-27. https://doi.org/10.71637/tnhj.v25i2.914

Mannan, S. J., Rezwan, R., Rahman, M. S., & Begum, K. (2017). Isolation and biochemical characterization of Lactobacillus species from yogurt and cheese samples in Dhaka metropolitan area. *Bangladesh Pharmaceutical Journal*, *20*(1), 27-33.

Nwike, M.I., Iheukwumere, I.H. and Uneze, B.C. (2017). Effect of Spices, pH and Temperature on the Survival and Multiplication of Staphylococcus aureus in Locally Made Soya Milk Drink. *Journal of Natural Sciences Research* 7(4).

Obianom, A.O. , Iheukwumere, I.H. , Iheukwumere, C.M. , Ochibulu, S.C., Nnadozie, H. C. and Ifenetu, F. C. (2024). Supersizing the inhibitory activity of Xylopia aethiopica extract against Vibrio cholerae using doxycycline. *Tropical Journal of Applied Natural Sciences* 2(2).

Obiefuna, U. G., Umeh, S. O., & Iheukwumere, I. H. (2025a). Assessing the Impact of Glycemic Index on Microbial Quality and Storage Stability of Tomato Jam. *IPS Journal of Applied Microbiology and Biotechnology*, *4*(3), 192–202. https://doi.org/10.54117/ijamb.v4i3.81

Obiefuna, U. G., Umeh, S. O., & Iheukwumere, I. H. (2025b). Physicochemical and nutritional properties of tomato jam: Influence of sweetener type and glycemic index. *IPS Journal of Nutrition and Food Science*, *4*(3), 561–568. https://doi.org/10.54117/yazv0114

Obiefuna, U. G., Umeh, S. O., & Iheukwumere, I. H. (2025c). Micronutrient profile and acceptability of tomato jam: A comparison of high and low glycemic carbohydrate index sweeteners. *IPS Applied Journal of Nutrition, Food and Metabolism Science*, *3*(2), 67–74. https://doi.org/10.54117/pr4r6c73

Okeke, C. E. Iheukwumere, I. H. Ejike, C.E. (2017). Pathogenicity Study of Dematiaceous Fungi Isolated from Chicken Feeds on Immunoincompetent Chickens. *J. Biol. Agriculture. Healthcare* 7(4).

Tufail, M., Hussain, S., Malik, F., Mirza, T., Parveen, G., Shafaat, S., ... & Sadiq, A. (2011). Isolation and evaluation of antibacterial activity of bacteriocin produced by Lactobacillus bulgaricus from yogurt. *African Journal of Microbiology Research*, *5*(22), 3842-3847.

Ugwu, C. H., Iheukwumere, I. H., Iheukwumere, C. M., Ike, V. E., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., Oduenyi, P. M., & Ochibulu, S. C. (2025a). Maternal health and antibiotic resistance: *Klebsiella pneumoniae* isolates analysis. *IPS Journal of Public Health*, *5*(3), 290–295. https://doi.org/10.54117/s3tx6v26

Ugwu, C. H., Iheukwumere, I. H., Iheukwumere, C. M., Ike, V. E., Dim, C. N., Ezendianefo, J. N., Egbe, P. A., Oragwu, I. P., Orji, C. C., Ogbonnaya, O. C., Onwuasoanya, U. F., Okereke, F. O., Oduenyi, P. M., & Ochibulu, S. C. (2025b). Ocimum gratissimum Extract's Effectiveness against Vibrio cholerae from Uli Streams. *IPS Journal of Phytochemistry and Medicinal Plant Research*, *1*(2), 15–19. https://doi.org/10.54117/ijpmpr.v1i2.38

Wang, C., Meng, F., Li, H., Zhao, L., Wu, C., & Guo, Y. (2022). Effect of dietary inclusion of fermented feather meal on growth performance, nutrient digestibility, and intestinal morphology of broiler chickens. *Animals*, *12*(3), 352. https://doi.org/10.3390/ani12030352

Wang, J., Yao, L., Su, J., Fan, R., Zheng, J., & Han, Y. (2023). Effects of Lactobacillus plantarum and its fermentation products on growth performance, immune function, intestinal pH, and cecal microorganisms of Lingnan yellow chicken. *Poultry Science*, *102*(6), 102610. https://doi.org/10.1016/j.psj.2023.102610

Yang, R., Khalid, A., Khalid, F., Ye, M., Li, Y., Zhan, K., Li, Y., Liu, W., & Wang, Z. (2022). Effect of fermented corn by-products on production performance, blood biochemistry, and egg quality indices of laying hens. *Journal of Animal Science*, *100*(5). https://doi.org/10.1093/jas/skac130

Yeh, R., Hsieh, C., & Chen, K. (2023). Two-Stage Fermented Feather Meal Enhances Growth Performance and Amino Acid Digestibility in Broilers. *Fermentation*, *9*(2), 128. https://doi.org/10.3390/fermentation9020128

Yu, L., Zhihui, C., Hongzhi, W., Fengjie, J., Yang, L., Jianing, L., ... & Liangmei, X. (2024). Effects of Fermented Puffed Feather Meal on Growth Performance, Serum Biochemical Indices, Meat Quality, and Intestinal Microbiota in Broilers. *Journal of Northeast Agricultural University*, *31*(3).

Zhang, Y., Liu, Y., Lv, L., & Wang, J. (2021). Probiotics in the prevention and treatment of colorectal cancer. *Frontiers in Immunology*, *12*, 714947. https://doi.org/10.3389/fimmu.2021.714947

Zhao, L., Zhang, F., Ding, X., Wu, G., Lam, Y. Y., Wang, X., ... and Zhang, C. (2022). Gut bacteria selectively promoted by dietary fibers alleviate type 2 diabetes. *Science*, *359*(6380), 1151-1156. https://doi.org/10.1126/science.aao5774.

Zhu, F., Zhang, B., Li, J., & Zhu, L. (2020). Effects of fermented feed on growth performance, immune response, and antioxidant capacity in laying hen chicks and the underlying molecular mechanism involving nuclear factor-κB. *Poultry science*, *99*(5), 2573-2580.

.