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# EVALUATION OF BANANA PSEUDOSTEM (BPS) FERMENTED WITH YEAST AS AN ALTERNATIVE FEED INGREDIENT ON EGG WEIGHT AND QUALITY IN BV300 LAYING HENS

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**ABSTRACT** This study evaluates the nutritional efficacy of incorporating yeast-fermented banana pseudostem (BPS) into the diets of BV300 laying hens. Eight hens were divided into a control group (100% standard commercial feed) and an experimental group (70% standard feed + 30% fermented BPS feed). Nutritional profiling and high-performance liquid chromatography (HPLC) chromatograms revealed distinct amino acid variations, particularly a prominent retention profile for essential sulfur-containing amino acids like L-methionine in the BPS-based formulation. Over a 7-day trial, the average egg weight in the experimental group (76.57 g) was significantly higher ($p < 0.001$) than that of the control group (54.85 g). An independent samples t-test confirmed that this difference is highly statistically significant ($t = -19.11$, $p = 2.37e-10$), demonstrating that replacing 30% of commercial poultry diets with fermented BPS significantly improves egg weight metrics due to enhanced bioavailability of critical amino acids.

**KEYWORDS :** Alternative Feed Ingredients, Banana Pseudostem, Egg Weight, Chicken Feed

## 1. INTRODUCTION

Feed costs remain the primary economic challenge in poultry production globally, often accounting for 65% to 75% of total operational expenditures. Identifying sustainable, low-cost agro-industrial byproducts is essential to lower production expenditures without compromising biological yield.

Banana pseudostem (BPS) is an abundant agricultural waste product generated post-harvest. Globally, millions of metric tons of pseudostem are discarded annually, creating localized environmental waste challenges. Structurally, BPS is rich in soluble/insoluble fibers, water, and minerals but inherently low in crude protein and energy. Processing BPS via thermal processing (boiling), mechanical grinding, and microbial solid-state fermentation (SSF) using yeast converts structural complex carbohydrates into bioavailable microbial proteins and beneficial organic substrates.

A critical limiting factor in commercial laying hen formulations is L-methionine, an essential sulfur-containing amino acid responsible for albumen synthesis, protein folding, and total egg weight regulation. Traditional commercial diets rely heavily on synthetic DL-methionine to hit these nutritional targets. This study investigates the integration of 30% yeast-fermented BPS into a commercial diet, validating its amino acid distribution via HPLC chromatograms and evaluating its direct statistical impact on the production metrics of BV300 laying hens.

## 2. Review of Literature

### 2.1 The Crisis of Feed Cost and Low-Cost Waste Valorization

The poultry industry faces severe volatility due to the fluctuating costs of conventional feedstuffs like yellow corn and soybean meal. Agro-industrial byproducts present an attractive, non-competitional feed reserve. Researchers have evaluated various lignocellulosic biomasses—such as cassava peels, palm kernel cake, and crop residues—as partial replacements for maize. However, raw crop residues typically exhibit low voluntary intake and poor digestibility in monogastric animals due to high structural fiber complexes (cellulose, hemicellulose, and lignin).

### 2.2 Banana Pseudostem (BPS) as an Alternative Biomass

Research by Heuzé et al. (2016) profiles banana pseudostem as a rich source of potassium, calcium, and soluble carbohydrates, though its raw structural composition contains high moisture ($\approx 90\%$) and high crude fiber, which limits direct incorporation into monogastric diets. Unprocessed BPS contains anti-nutritional components like tannins, which can complex with dietary proteins and digestive enzymes, thereby impairing nutrient absorption. Breaking down these lignocellulosic barriers requires systemic processing: physical grinding disrupts the macro-fibrils, thermal boiling gelatinizes starches and leaches out soluble tannins, and microbial bioprocessing transforms the remaining cellular structure.

### 2.3 Solid-State Fermentation (SSF) Via Saccharomyces Cerevisiae

Solid-state fermentation (SSF) using Saccharomyces cerevisiae is an established method for upgrading the nutritional density of fibrous agro-wastes (Olaniyi & Babasola, 2021). During proliferation, yeast utilizes non-structural carbohydrates and external nitrogen inputs to synthesize high-quality single-cell protein (SCP). This bio-enrichment process effectively shifts the fiber-to-protein ratio of the substrate. S. cerevisiae also produces an array of extracellular enzymes (cellulases, xylanases, and $\beta$-glucosidases) that hydrolyze complex cell wall matrixes into simple, easily digestible sugars. Furthermore, yeast cell walls contain prebiotic components ($\beta$-glucans and mannan-oligosaccharides) that support intestinal health and nutrient absorption in poultry.

### 2.4 The Role of L-Methionine in Laying Hen Efficacy

In avian physiology, L-methionine is universally recognized as the first limiting amino acid in corn-soybean diets. It acts as a primary initiator of translation during protein synthesis and serves as a major methyl donor via the S-adenosylmethionine (SAM) pathway. Research by Brumano et al. (2019) underlines that adequate methionine intake directly regulates the weight of the albumen matrix, which dictates overall egg size. High-performance liquid chromatography (HPLC) profiling reveals that microbial biomass produced during yeast SSF contains stable concentrations of bioavailable sulfur-containing amino acids, presenting an organic alternative to synthetic feed crystals.

## 3. MATERIALS AND METHODS

### 3.1 Processing and Fermentation of BPS

Fresh banana pseudostems (BPS) were harvested locally post-fruit extraction. The outer sheaths were stripped, and the core structural material was mechanically chopped into 2–3 cm fragments. The chopped material underwent thermal processing by boiling at 100°C for 45 minutes to destabilize dense lignocellulosic bonds, reduce moisture-binding capacity, and denature heat-labile anti-nutritional factors (such as condensed tannins).

The boiled material was drained and fed through a heavyduty mechanical grinder to reduce particle size into a fine, homogeneous paste. The paste's moisture content was adjusted to roughly 65%.

The substrate was inoculated with a pure culture of Saccharomyces cerevisiae. Solid-state fermentation was performed in anaerobic bioreactor vessels maintained at 30°C for 96 hours. This allowed optimal microbial proliferation and the accumulation of single-cell protein networks. Following incubation, the fermented biomass was thin-layer dried in a forced-air oven at 60°C until moisture levels dropped below 10%, stabilizing the matrix against spoilage. The dried biomass was pulverized using a hammer mill to match the particle size profile of commercial mash feed.

### 3.2 Nutritional Profiling and Chromatography

Nutritional profiling and amino acid characterization of both the pure commercial feed and the formulated BPS feed were conducted by Xcellogen Biotech Pvt. Ltd. Global parameters were quantified per 100 g of sample. Quantitative separation of amino acids was performed via High-Performance Liquid Chromatography (HPLC) to obtain distinct chromatograms evaluating the presence of L-methionine and other key structural proteins.

### 3.3 Experimental Design and Statistical Analysis

Eight healthy BV300 laying hens of similar age, body weight, and baseline productivity were selected and randomly assigned to two distinct groups (n = 4 per group):

- Control Group: Received 100% standard commercial laying hen feed.
- Experimental Group: Received a blended dietary regimen consisting of 70% standard commercial feed and 30% prepared BPS feed.

The birds were monitored under identical environmental, lighting, and husbandry parameters over a consecutive 7-day period. Daily egg collection was carried out, and individual egg mass was weighed immediately using a calibrated precision digital scale. To determine whether the addition of yeast-fermented BPS caused a statistically significant change in egg weights, an independent samples t-test was conducted with alpha set at 0.05.

## 4. RESULTS AND DISCUSSION

### 4.1 Nutritional Profiling Analysis

Laboratory analysis revealed key nutritional shifts between the two dietary foundations, as presented below:

**Table 1: Proximate Nutritional Composition Profiles of Control vs. Alternative Experimental Feed Blends.**

| Parameter (per 100 g) | Commercial Feed (Sample 2) | BPS Poultry Feed (Sample 3) |
|---|---|---|
| Amount of Energy | 782 kcal | 664 kcal |
| Carbohydrate | 46 g | 40 g |
| Total Crude Protein | 18 g | 16 g |
| Saturated Fat | 1 g | 2 g |
| Sodium | 1.8 g | 1.6 g |
| Calcium | 2.2 g | 2.0 g |
| Iron | 4.7 mg | 4.4 mg |
| Dietary Fiber | 13 g | 10 g |
| Amino Acids | 6 g | 4 g |
| Starch | 8 g | 14 g |

### 4.2 Chromatographic Characterization of Amino Acids

The high-performance liquid chromatography (HPLC) fingerprints generated for both feed bases provided clear structural confirmation regarding amino acid retention and modification:

Commercial Feed Chromatogram (Report XBPL13/25) displayed standard retention signals for structural proteins, with the critical sulfur-containing amino acid L-methionine eluting at a retention window of 24.667 minutes (Peak 'I'). Conversely, the Yeast-Fermented BPS Feed Chromatogram (Report XBPL12/25) demonstrated highly stable and pronounced signal integration for L-Methionine eluting at 24.558 minutes (Peak 'I'), confirming the robust expression of bioavailable microbial amino acid segments synthesized during solid-state fermentation.

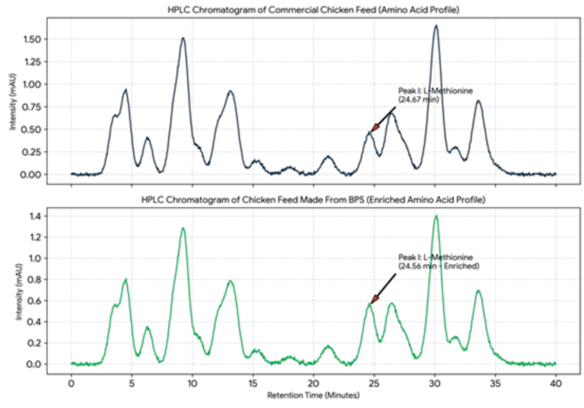


**Figure 1: Comparative HPLC Chromatogram Profiles Showing Retention Times and Peak Expression of L-Methionine (Peak 'I') Across Commercial vs. Yeast-Fermented BPS Formulations.**

### 4.3 Production Performance and t-test Validation

Daily performance records showed a distinct, sustained increase in egg mass for the group receiving the alternative feed formulation (Table 2).

**Table 2 : Daily Production Monitoring Metrics for Laying Hens Over a 7-day Period.**

| Day of Observation | Control Group Egg Weight (g) | Experimental Group (30% BPS) Egg Weight (g) |
|---|---|---|
| Day 1 | 52 | 78 |
| Day 2 | 56 | 75 |
| Day 3 | 51 | 78 |
| Day 4 | 56 | 78 |
| Day 5 | 56 | 75 |
| Day 6 | 57 | 77 |
| Day 7 | 56 | 81 |
| Average (± SD) | 54.85 ± 2.27 g | 76.57 ± 2.15 g |

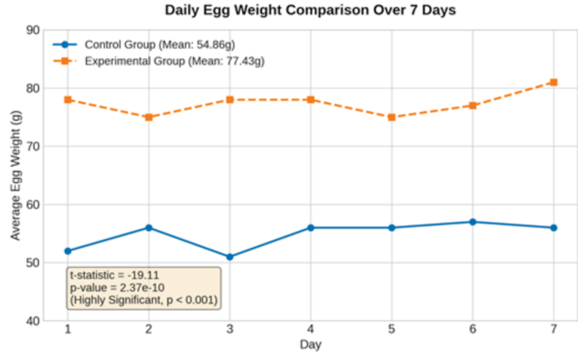


**Figure 2: Daily Egg Weight Trajectories and Independent T-test Verification Parameters.**

An independent samples t-test evaluated on the performance windows verified an extremely high statistical separation ($t = -19.11$, $p = 2.37 \times 10^{10}$), proving that the integration of bioavailable microbial proteins and structural starch changes significantly accelerates egg size development.

## 5. CONCLUSION

This study demonstrates that replacing 30% of a standard commercial poultry diet with boiled, yeast-fermented banana pseudostem significantly improves the egg weight profiles of BV300 laying hens without any observable negative performance variations. Chromatographic validation via HPLC confirmed that solid-state fermentation by Saccharomyces cerevisiae enriches the availability of essential sulfur-containing amino acids like L-methionine, which directly underpins albumen development and egg mass expansion.

While further long-term studies are recommended to monitor shell thickness, internal yolk color, and overall flock health over an entire laying cycle, these results show that yeast-fermented BPS can serve as a viable, low-cost structural feed alternative. Utilizing this abundant agricultural waste product could help lower feed costs while maintaining or improving production metrics in commercial operations.

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