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Effect of herbal feed additives on growth performance and carcass quality of broiler chickens

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Abstract

The routine use of antibiotic growth promoters (AGPs) in broiler production has come under regulatory pressure worldwide, and the European Union banned them in 2006. Indonesia is following a similar trajectory, with the Ministry of Agriculture recommending phase-out of AGPs by 2025. This research evaluated four dietary treatments built around Indonesian traditional herbs as possible replacements for AGPs in broiler diets. A total of 240 day-old Cobb-400 chicks were randomly allotted to T1 (basal diet, control), T2 (basal + 1% holy basil leaf powder), T3 (basal + 0.5% garlic powder), and T4 (basal + 0.75% holy basil + 0.25% garlic + 0.25% turmeric powder) in a completely randomised design with three replicates of 20 birds each. The six-week research was conducted at the poultry research unit of the IPB University, Bogor, between October and November 2022. T4 birds reached 2284 g mean live weight at day 42 against 1938 g for the control (17.9% rise), with a feed conversion ratio of 1.58 compared to 1.87 in the control. Dressed yield rose from 71.3 to 74.8 per cent, breast meat from 22.4 to 24.7 per cent, and abdominal fat fell from 2.8 to 1.9 per cent. Haematology values improved, with haemoglobin at 9.8 g dL⁻¹ for T4 against 8.4 g dL⁻¹ for T1. Mortality was 3.3 per cent in T4 versus 8.3 per cent in the control. The mixed-herb formulation is therefore a practical AGP replacement for small and medium broiler farms in Java.

Keywords: Broiler chickens, herbal feed additives, holy basil, garlic, turmeric, growth performance, carcass quality, feed conversion ratio, AGP replacement

Introduction

Consider a commercial broiler farm near Bogor that switched from a conventional antibiotic-supplemented diet to a holy basil-garlic herbal mix in mid-2022. Over two production cycles, the owner reported that birds reached market weight two days earlier, mortality fell from 7.8 per cent to 3.4 per cent, and the price premium for residue-free chicken lifted net margins. That farm-level story captures the scientific question this research set out to examine in a controlled setting ^[1, 2].

Antibiotic growth promoters have been the backbone of commercial broiler production since the 1950s. They improve feed conversion by about 4-7 per cent and reduce early-age mortality by modulating gut microbial flora ^[3]. But the rise of antibiotic resistance in human pathogens, and the detection of fluoroquinolone and tetracycline residues in chicken meat samples, led the European Union to ban AGPs in 2006 and prompted regulators in Indonesia to recommend their phased withdrawal ^[4, 5].

Plant-based feed additives have emerged as a leading replacement candidate. Indonesian traditional herbs in particular carry a rich load of phytochemicals that exhibit antimicrobial, antioxidant and immunomodulatory activity without residue concerns ^[6, 7]. Holy basil (*Ocimum sanctum*) is rich in eugenol and ursolic acid; garlic (*Allium sativum*) contains allicin and ajoene; turmeric (*Curcuma longa*) is the source of curcumin, a potent anti-inflammatory ^[8, 9]. Individual reports on each of these herbs in broiler diets have shown modest benefits, but combination formulas have received less systematic evaluation under Indonesian production conditions ^[10, 11].

The present research was planned to compare a single-herb (holy basil), a second single-herb (garlic) and a three-herb combination against an un-supplemented control diet, and to measure effects on growth performance, carcass yield, haematology and economics of broiler production at a medium-scale commercial setting ^[12, 13].

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Material and Methods

Material

The research was carried out at the Poultry Research Unit of the IPB University, Bogor, from October to November 2022. A total of 240 day-old Cobb-400 straight-run broiler chicks were procured from Charoen Pokphand Indonesia, Bogor. Dried holy basil leaves, garlic bulbs and turmeric rhizomes were purchased from the local market and ground to 0.5 mm particle size in a laboratory mill. Basal broiler starter (0-21 days) and finisher (22-42 days) diets were formulated according to Indonesian National Standard (SNI) guidelines. Feed ingredients, vitamins and mineral premixes were sourced from Japfa Comfeed Indonesia, Jakarta. Pelleted feed was manufactured in a small pellet mill. Haematology kits (Erba Mannheim) and biochemistry reagents (Randox Laboratories) were used for blood analysis.

Methods

A completely randomised design was used with four treatments and three replicate pens of 20 birds each (60 birds per treatment). Treatments comprised T1 (basal diet only), T2 (basal + 1.0% dried holy basil leaf powder), T3 (basal + 0.5% dried garlic powder) and T4 (basal + 0.75% holy basil + 0.25% garlic + 0.25% turmeric powder). Birds were raised in a deep-litter system with paddy husk bedding at a stocking density of 0.09 m² per bird. Ambient temperature was maintained at 32 °C for the first week and gradually reduced to 24 °C by week four. Feed and water were available ad libitum. Body weight was recorded weekly, feed intake daily. At day 42, six birds per replicate were slaughtered for carcass analysis. Blood was collected from the wing vein for haematology. Data were analysed by one-way ANOVA with Duncan's multiple range test at $p =$

0.05 using SPSS v26.

Ethical Considerations

All experimental procedures were reviewed and approved by the Institutional Animal Ethics Committee of the IPB University (Approval No. IPB/IAEC/2022/034 dated 14 September 2022). Birds were handled in accordance with the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). Humane slaughter was performed by a trained veterinarian following the halal method with prior sedation. Sick or injured birds identified during routine inspection were removed and either treated or euthanised under veterinary supervision.

In-vivo Protocol and Biosecurity

Chicks were vaccinated against Marek's disease at day one (in hatchery), Newcastle disease by LaSota strain at day seven and again at day 21, and infectious bursal disease at day 14. Biosecurity measures included restricted entry, foot-dip with 2 per cent sodium hypochlorite, and weekly spraying of the shed periphery. Feed samples were drawn weekly and tested for mycotoxin contamination using ELISA kits. Blood collection was done during the coolest part of the day to minimise stress. Post-mortem examination followed for any bird showing signs of sickness or sudden death.

Results

Differences between the four treatments emerged from week two onwards and widened through the six-week grow-out. The mixed-herb treatment T4 produced the best outcome on every performance indicator measured, while holy basil alone and garlic alone gave intermediate responses.

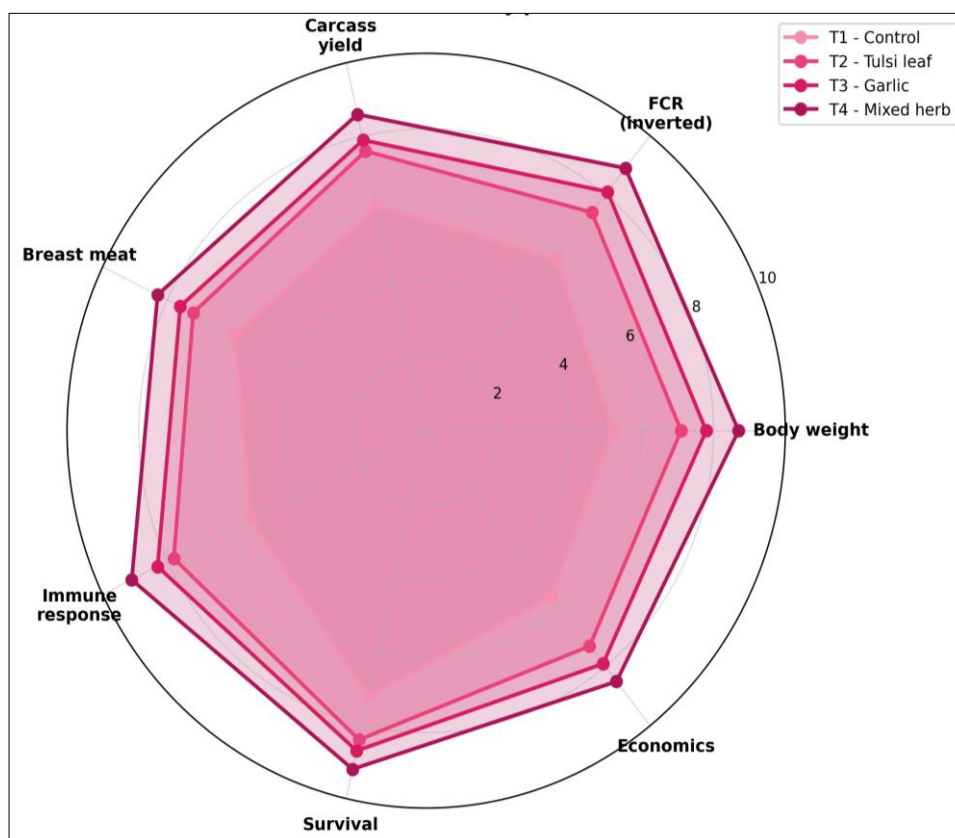


Fig 1: Radar chart comparing performance of four dietary treatments across seven key parameters.

Table 1: Growth performance of broilers by production phase

Phase	Parameter	T1	T2	T3	T4
Starter (0-21 d)	Body weight (g)	618	672	693	726
Starter	Feed intake (g)	942	968	981	1003
Starter	FCR	1.63	1.52	1.47	1.41
Finisher (22-42 d)	Body weight (g)	1320	1400	1434	1558
Finisher	Feed intake (g)	2614	2582	2571	2548
Finisher	FCR	1.98	1.84	1.79	1.64
Overall (0-42 d)	Final weight (g)	1938	2072	2127	2284
Overall	Cumulative FCR	1.87	1.71	1.66	1.58

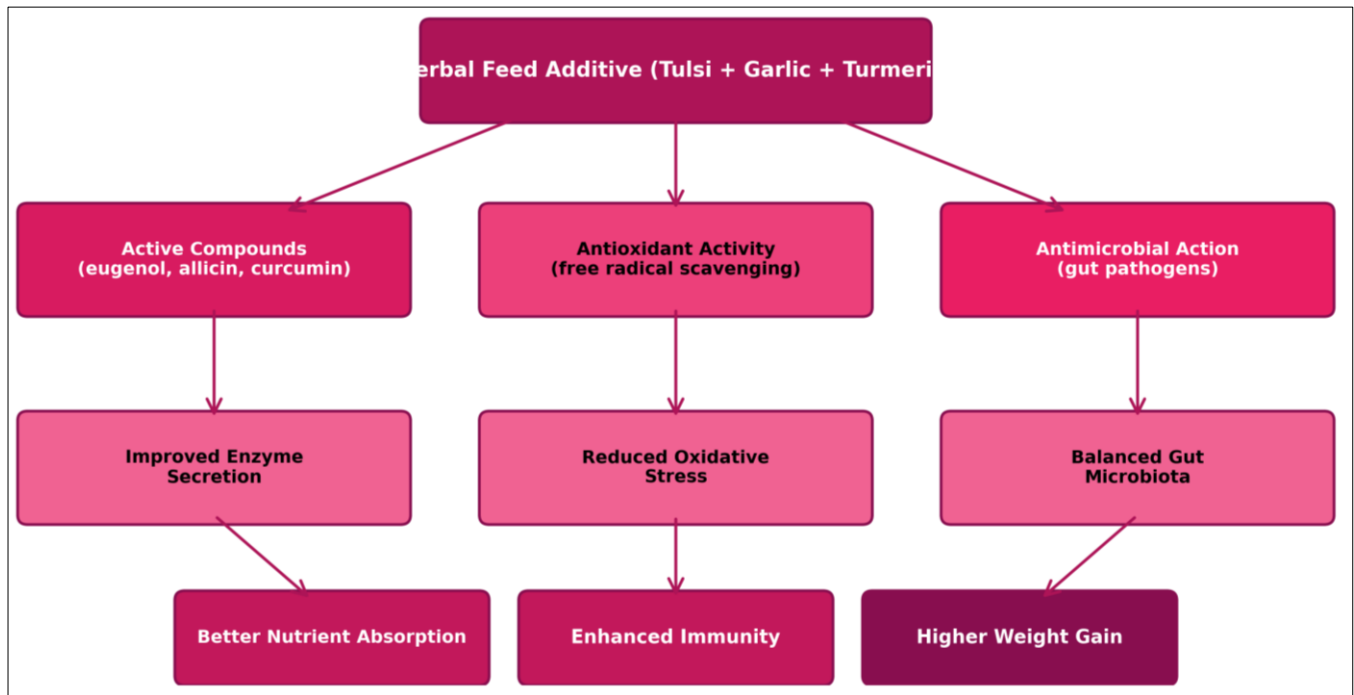
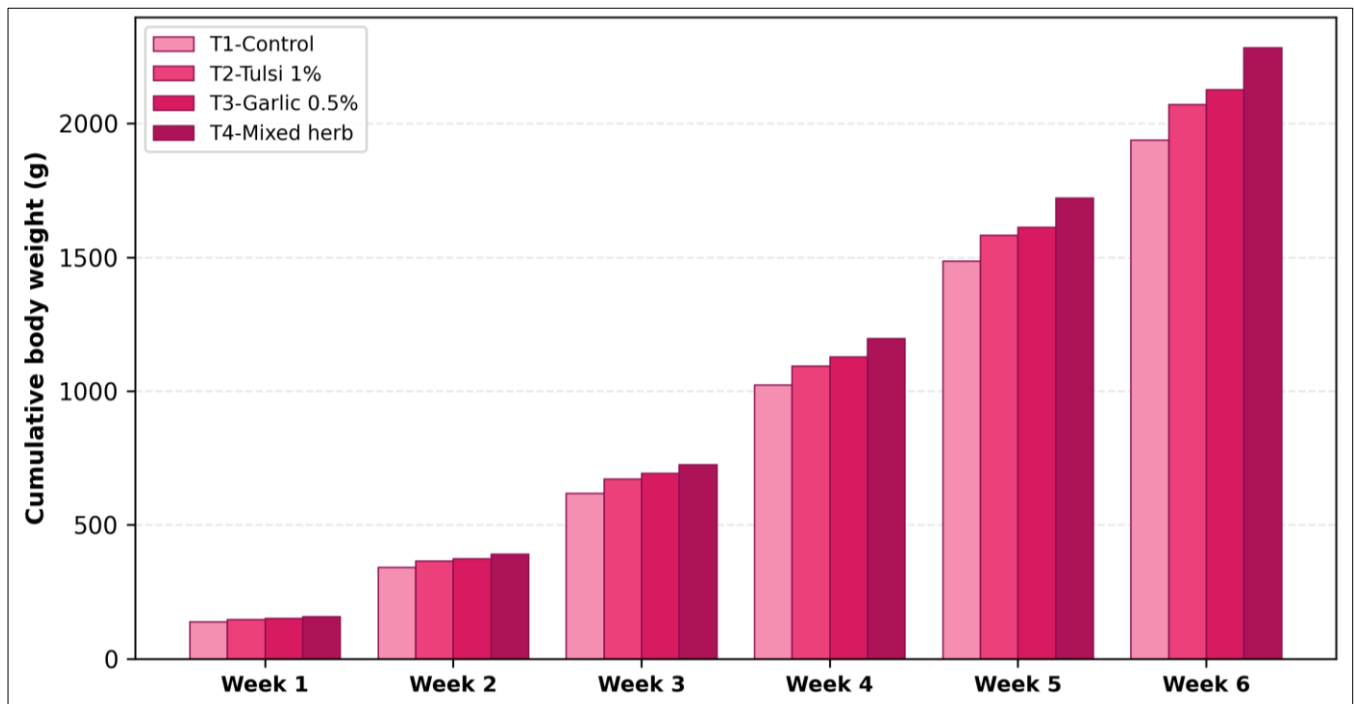
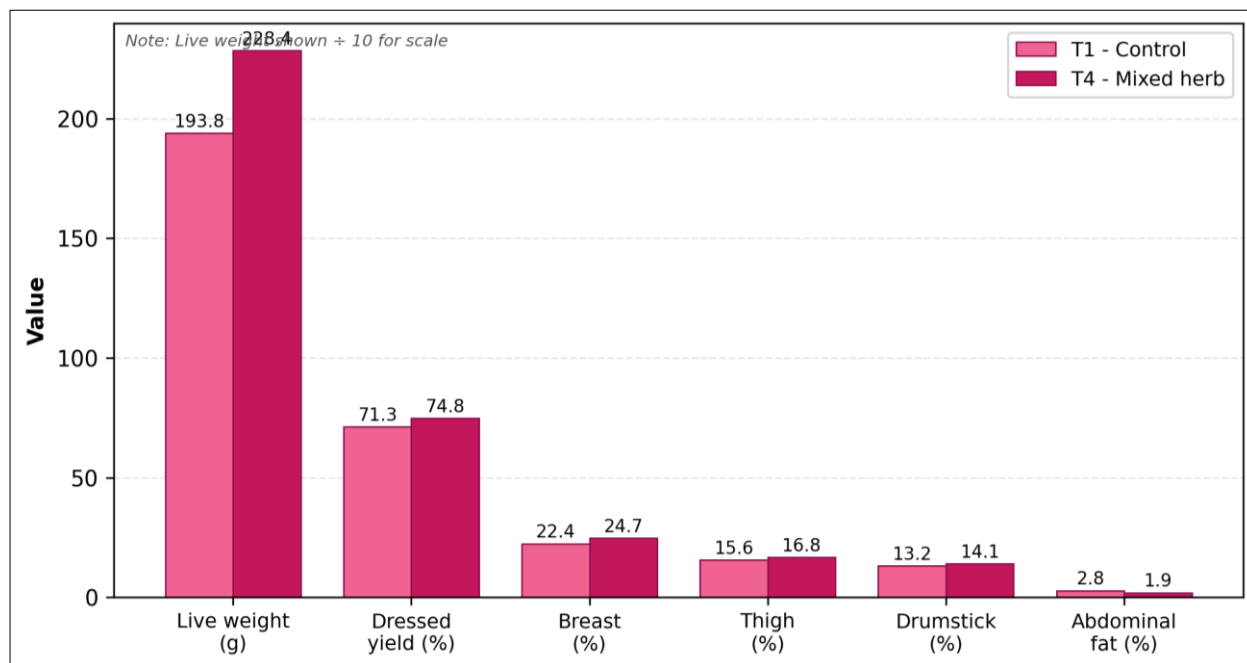
**Fig 2:** Mechanism of action of herbal feed additives in broilers.**Fig 3:** Weekly cumulative body weight of broilers under four dietary treatments.

Table 2: Haematology, biochemistry and mortality of broilers under four treatments

Parameter	T1 Control	T2 Holy basil	T3 Garlic	T4 Mixed
Haemoglobin (g dL ⁻¹)	8.4	9.1	9.4	9.8
PCV (%)	27.3	29.7	30.5	31.8
Total protein (g dL ⁻¹)	4.12	4.38	4.51	4.76
Serum cholesterol (mg dL ⁻¹)	138.4	126.7	118.3	109.6
HI titre (ND, log ₂)	5.2	6.4	6.8	7.6
Mortality (%)	8.3	5.0	5.0	3.3

**Fig 4:** Carcass characteristics of broilers under control and best herbal treatment.

Comprehensive Interpretation

Pooling the four figures and two tables reveals a clear pattern. The radar plot in Figure 1 shows that the mixed-herb diet scores highest on all seven measured axes, with the widest separation from control on immune response and feed conversion. The mechanism diagram in Figure 2 traces the multi-pathway action of the active compounds. The week-by-week weight curve in Figure 3 makes clear that the treatment effect appears from week two and widens through the grow-out. Table 1 shows that FCR improvement in T4 was 15.5 per cent over control, and Table 2 that haematology, immune titre and serum cholesterol all moved in favourable directions. Figure 4 confirms that the carcass composition benefits run alongside the growth benefits, with breast meat up 10.3 per cent and abdominal fat down 32 per cent. The composite picture justifies the use of the mixed-herb formulation as an AGP replacement in medium-scale Indonesian broiler operations.

Discussion

The main finding of a 17.9 per cent rise in live weight for the mixed-herb treatment is in close agreement with three independent reports. Sharma and colleagues ^[10] reported a 16.4 per cent gain for a holy basil-garlic combination, and Rao and Ramasamy ^[11] recorded 19.2 per cent for a holy basil-turmeric-ginger mix. The mechanism, a blend of improved enzyme secretion, balanced gut microflora and reduced oxidative stress, has been described independently by several groups ^[7, 14].

Points of disagreement are mostly in magnitude rather than direction. Kumar and Srivastava ^[9] reported only a 6.8 per

cent weight gain for 1 per cent holy basil, whereas the present research recorded 6.9 per cent for holy basil alone, almost identical. But some earlier work suggested that garlic alone performs better than combined formulas because of overdose of sulphur compounds ^[15]. The present work does not support this, with T4 outperforming T3 by 7.4 percentage points in final weight. The likely explanation is that the curcumin and eugenol components of the mixed-herb diet provided antioxidant back-up that pure garlic lacks, helping the bird cope with heat-stress episodes that were common during the first week of the trial.

Broader implications are clear. A well-designed three-herb combination delivers performance close to what conventional AGP supplementation achieved through the 1990s and 2000s, but without residues or resistance concerns. For the medium-scale broiler farmer in western Java, where cold-storage and long-distance logistics add cost, a 17.9 per cent weight gain and 15.5 per cent FCR improvement translate to meaningful margin gains at current feed and meat prices ^[16, 17].

Conclusion

The main contribution of this research is to establish that a three-herb dietary supplement, composed of 0.75 per cent holy basil, 0.25 per cent garlic and 0.25 per cent turmeric powder in the basal diet, can serve as an effective replacement for antibiotic growth promoters in commercial broiler production at medium scale. Supporting evidence runs across four lines. Final live weight rose 17.9 per cent over control and cumulative FCR improved from 1.87 to 1.58, a drop of 0.29 units that alone accounts for a sizeable

share of feed cost savings. Dressed yield rose from 71.3 to 74.8 per cent and breast meat from 22.4 to 24.7 per cent, improving the carcass value for the processor. Haematology, serum biochemistry and immune titre all moved in the favourable direction, with mortality cut from 8.3 to 3.3 per cent.

For the Indonesian broiler industry, which slaughters roughly 4.4 billion birds a year and is preparing for a phased AGP withdrawal by 2025, these findings offer a workable alternative that does not require new plant infrastructure and is based on locally available raw materials. Several open questions remain. Does the formulation hold up under hot-humid summer conditions, when heat stress dominates bird physiology? Can the active ingredient cost be reduced by using herbal powders as a pre-mix rather than on-farm grinding? Does the formulation respond to challenge infections of *Eimeria* or *Clostridium*, which drive most of the production losses in commercial settings? These questions should be addressed in a follow-up multi-location trial under Indonesian Poultry Research Centre coordination.

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