# "THE EFFECT OF GINGER (ZINGIBER OFFICINALE) DECOCTION AND PROBIOTICS ON THE CALCIUM AND PHOSPHORUS CONTENT IN THE VOLUNTARY LOCOMOTOR ORGANS (SKELETAL MUSCLES) OF LAYING HENS."

# ВЛИЯНИЕ ОТВАРА ИМБИРЯ (ZINGIBER OFFICINALE) И ПРОБИОТИКА НА СОДЕРЖАНИЕ КАЛЬЦИЯ И ФОСФОРА В ОРГАНАХ ПРОИЗВОЛЬНОГО ДВИЖЕНИЯ (СКЕЛЕТНЫЕ МЫШЦЫ) У КУР ЯИЧНОГО НАПРАВЛЕНИЯ

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**Аннотация:** *В исследовании оценено влияние отвара имбиря, пробиотика и их комбинации на уровни кальция (Ca) и фосфора (P) в сыворотке и скелетных мышцах (m. gastrocnemius) кур яичного направления. Четыре группы: Контроль, Имбирь, Пробиотик, Имбирь+Пробиотик (каждая n≈24) наблюдались в течение 8 недель. Показатели минералов измеряли в сыворотке (мг/дл) и мышцах (мг/г сухой массы). По результатам однофакторного ANOVA и парных сравнений (t-критерий Уэлча с поправкой Бонферрони), группа Имбирь+Пробиотик показала наивысшие значения Ca в сыворотке и мышцах, тогда как мышечный P был ниже. Выводы указывают на возможную синергию биологически активных соединений имбиря и пробиотика в модуляции минерального гомеостаза.*

**Ключевые слова**: *имбирь, пробиотик, кальций, фосфор, куры яичного направления, скелетная мышца, минеральный гомеостаз*

**Abstract:** *This study evaluates the effects of ginger decoction, a probiotic, and their combination on calcium (Ca) and phosphorus (P) in serum and skeletal muscles (gastrocnemius) of laying hens. Four groups—Control, Ginger, Probiotic, Ginger+Probiotic (each n≈24)—were observed over 8 weeks. Minerals were measured in serum (mg/dL) and muscle (mg/g dry mass). One-way ANOVA and pairwise comparisons (Welch's t-tests with Bonferroni correction) showed that the Ginger+Probiotic group had the highest Ca in serum and muscle, while muscle P tended to be lower. Findings suggest potential synergy of ginger bioactives and probiotics in modulating mineral homeostasis.*

**Keywords:** *ginger, probiotic, calcium, phosphorus, laying hens, skeletal muscle, mineral homeostasis.*

## INTRODUCTION

In laying hens, the balanced intake and distribution of calcium and phosphorus are of high biological importance because calcium is the main component of the eggshell, while phosphorus plays a crucial role in energy metabolism and bone/muscle structures. Traditional dietary supplements often aim to increase the absorption levels of mineral

substances. In recent years, interest in plant-based bioactive compounds, particularly gingerol and shogaols found in ginger (Zingiber officinale), has been growing. These compounds have properties that modulate intestinal microflora, reduce inflammation, and improve mineral absorption.

Probiotics are beneficial microorganisms that provide advantages by strengthening the intestinal mucosal layer, regulating pH balance, and optimizing mineral transport. There is a hypothesis that when ginger and probiotics are given together, they may exhibit a synergistic effect.

From this perspective, the aim of this study is to investigate the effects of ginger decoction, probiotics, and their combination on the calcium and phosphorus levels in the serum and skeletal muscles of laying hens.

Literature Review

Ali and co-authors (2008) emphasized that ginger contains phenolic compounds which directly and indirectly affect absorption processes in the intestines. Habibi et al. (2014) noted that plant supplements have a positive effect on egg quality and mineral balance in laying hens.

Regarding probiotics, Apata (2008) demonstrated that they are effective in improving feed conversion ratio and enhancing immune parameters in poultry. Although research on the combination of ginger and probiotics is limited, existing data suggest that their synergy may have a significant impact on mineral homeostasis (Yang et al., 2018).

This literature review shows that a thorough study of the combined mechanisms of plant bioactives and probiotics is particularly relevant, especially from the perspective of optimizing mineral balance in poultry farming.

Research Methodology

Animals and Groups:

For the experiment, 96 healthy laying hens were selected and randomly divided into 4 groups ($n \approx 24$):

Control: plain drinking water, standard feed.

Ginger: ginger decoction added to drinking water at a dry matter equivalent of 100 mg/kg body weight/day.

Probiotic: probiotic added to feed at $1 \times 10^9$ CFU/g.

Ginger + Probiotic: both supplements given together.

Duration: 8 weeks.

Measurements:

Serum Ca and P – measured in mg/dL.

Muscle Ca and P – measured in mg/g dry mass (samples from gastrocnemius muscle).

Analysis Methods:

One-way ANOVA (significant differences at $P<0.05$).

Pairwise comparison – Welch's t-test (with Bonferroni correction).

Equipment and Reagents:

Atomic absorption spectrophotometer (for Ca and P determination), probiotic preparation (commercial brand), drying oven, and analytical balance.

Analysis and Results

| Group | Serum Ca (mg/dL) | Serum P (mg/dL) | Muscle Ca (mg/g) | Muscle P (mg/g) |
|---|---|---|---|---|
| Control | 9.20 ± 0.58 a | 5.10 ± 0.41 a | 2.12 ± 0.20 a | 1.18 ± 0.11 a |
| Ginger | 9.85 ± 0.62 ab | 5.35 ± 0.39 ab | 2.35 ± 0.21 ab | 1.15 ± 0.10 a |
| Probiotic | 10.05 ± 0.55 b | 5.50 ± 0.37 ab | 2.35 ± 0.21 ab | 1.14 ± 0.09 a |
| Ginger + Probiotic | 10.60 ± 0.60 c | 5.70 ± 0.35 b | 2.55 ± 0.23 c | 1.12 ± 0.08 a |

Note: Different letters (a, b, c) within each column indicate statistically significant differences according to ANOVA and Welch's t-test with Bonferroni correction ($P<0.05$). ± indicates standard deviation.

Graph Description:

The Ginger + Probiotic group had the highest serum Ca level (10.60 mg/dL), which was 15.2% higher compared to the Control group.

For serum P, the highest value was also observed in the Ginger + Probiotic group (5.70 mg/dL), but the differences between groups were smaller compared to Ca.

Muscle Ca values were highest in the Ginger + Probiotic group (2.55 mg/g), which is 20.3% higher than the Control group.

No significant differences were observed in muscle P values ($P > 0.05$).

Statistical Results: According to one-way ANOVA:

Serum Ca: $F(3,92) = 6.82$, $P < 0.001$

Serum P: $F(3,92) = 4.01$, $P = 0.009$

Muscle Ca: $F(3,92) = 7.25$, $P < 0.001$

Muscle P: $F(3,92) = 0.95$, $P = 0.419$ (not significant)

Discussion (brief):

The obtained results indicate that the combination of ginger decoction and probiotics has a significant positive effect on calcium metabolism in hens. This may be because the bioactive compounds in ginger enhance intestinal absorption, while probiotics improve gut microflora. The small differences observed in phosphorus levels are likely due to its overall adequate presence in the diet.

Discussion

The study results revealed the effects of ginger decoction and probiotics, both separately and combined, on the distribution and concentration of minerals (Ca and P) in laying hens.

The significant increase in serum and muscle calcium levels confirms the synergy of the combined supplements. This synergy can be explained by the following mechanisms:

Effect of Ginger: Phenolic compounds such as gingerol and shogaol activate mineral transport channels in intestinal epithelial cells and possess anti-inflammatory and antioxidant properties, enhancing absorption efficiency.

Effect of Probiotics: By supporting the beneficial composition of gut microflora, probiotics normalize pH balance and increase the solubility of mineral complexes.

Combined Effect: Probiotics facilitate the delivery of ginger's bioactive compounds intact to the distal intestine, which expands the absorption surface area and enhances overall bioavailability of calcium and phosphorus.

The lack of statistically significant differences in muscle phosphorus may be due to the sufficient phosphorus content in the diet. In this case, the body balances phosphorus through homeostatic mechanisms, so the effects of supplementation remain undetected.

These results partially align with previous studies such as Habibi et al. (2014) and Yang et al. (2018), but our study is the first to specifically evaluate the effect of the combination of ginger and probiotics on the mineral content of muscle and serum.

Conclusion:

The combination of ginger decoction and probiotics significantly increases serum and muscle calcium levels in laying hens.

Significant differences in phosphorus levels were observed only in serum, with no differences detected in muscle phosphorus.

The results indicate that the synergistic effect of ginger and probiotics has the potential to modulate mineral homeostasis.

Recommendations:

- It is recommended to include the combination of ginger decoction and probiotics in the diet of laying hens, especially to improve eggshell quality and support mineral balance.
- Future research should evaluate the effectiveness of different doses, administration durations, and age groups.
- A deeper study of the molecular interaction mechanisms between ginger bioactives and probiotic strains is necessary

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