UNIVERSITY OF KRAGUJEVAC

FACULTY OF AGRONOMY IN ČAČAK

SYMBIOTECH

4th INTERNATIONAL SYMPOSIUM ON BIOTECHNOLOGY

12–13 March 2026

Faculty of Agronomy in Čačak, University of Kragujevac, Serbia

- PROCEEDINGS -

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

63(082)
606:63(082)

INTERNATIONAL Symposium on Biotechnology (4 ; 2026 ; Čačak)
Proceedings / 4th International Symposium on Biotechnology, SYMBIOTECH, 12–13 March 2026, Čačak ; [organizer] University of Kragujevac, Faculty of Agronomy in Čačak. - Kragujevac : University, Faculty of Agronomy in Čačak, 2026 (Čačak : Ofis servis "Čačak").
- 962 str. : ilustr. ; 24 cm

"XXXI Savetovanje o biotehnologiji sa međunarodnim učešćem" --> kolofon. - Tiraž 30. - Bibliografija uz svaki rad.

ISBN 978-86-87611-99-3

a) Пољопривреда -- Зборници b)
Биотехнологија -- Зборници

COBISS.SR-ID 189033481

DOI: 10.46793/SYMBIOTECH26

4th INTERNATIONAL SYMPOSIUM ON BIOTECHNOLOGY
12-13 March 2026, Čačak

Original scientific paper
DOI: 10.46793/SBT26.447R

EFFECT OF LAYING HEN GENOTYPE ON EGG QUALITY IN A FLOOR REARING SYSTEM

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Abstract: The aim of this study was to evaluate the effect of genotype (Isa Brown and New Hampshire) on egg quality in a floor rearing system. Fifteen eggs per group were collected at 32 weeks of age and analyzed for external and internal quality parameters (egg weight, shape index, albumen height, Haugh unit, yolk color, and shell breaking strength), as well as for chemical composition (dry matter, minerals, protein, and lipids).

Eggs from Isa Brown hens exhibited greater egg weight, higher shape index, and superior shell breaking strength, whereas New Hampshire eggs had more intensely pigmented yolks. No significant differences were observed in albumen height or Haugh units between the genotypes. Regarding chemical composition, significant differences were found only in lipid content, which was higher in New Hampshire eggs. No significant differences were detected in dry matter, mineral, or protein content.

Keywords: Isa Brown, New Hampshire, floor rearing system, egg quality, chemical composition of eggs.

Introduction

Consumers are increasingly demanding eggs from animal welfare-friendly farms. Beyond the ethical aspects, the consumer associates eggs produced in not cages systems, as a food providing added value in terms of acceptability, nutrition, taste (Gautron et al., 2022). The floor rearing system for laying hens is becoming increasingly widespread worldwide, particularly in European countries, and is emerging as the most viable alternative to conventional cage systems, which are scheduled to be banned in the member states of the

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European Union from 2027 onwards. Currently, 38.9% of the total laying hen population in the European Union is reared in this system, representing a substantial increase compared to 28.5% recorded in 2018. At the level of individual countries, the highest shares are observed in Slovenia (79.2%), Sweden (78.2%), Netherlands (63.1%) and Finland (62.9%) (European Commission, 2025).

Within this production system, the maximum stocking density is seven birds per square meter, with up to two-thirds of the available area consisting of slatted flooring and one-third comprising solid flooring covered with litter. The housing facilities are also equipped with nest boxes, typically installed along the walls of the building and arranged on multiple tiers.

With the increasing adoption of floor-based rearing systems in laying hen production, the selection of an appropriate genotype has become particularly important, as most high-performing commercial hybrids were primarily developed for cage systems. Although these hybrids are expected to maintain their leading position, it remains uncertain whether alternative genotypes, particularly purebred lines, may also perform well under such conditions. While pure breeds generally exhibit lower production performance, they are often more robust and adaptable to diverse rearing environments, making them well-suited for alternative systems. This is particularly relevant given the growing consumer demand in recent years for poultry products derived from native breeds reared in extensive systems (Calik and Obzrut, 2023).

Materials and methods

The experiment was arranged with two layer genotypes (Isa Brown hybrid and dual-purpose New Hampshire breed; 30 birds per group) in floor rearing system.

These two genotypes were housed when hens were 18 weeks of age. Stocking density was 2.5 birds/m^2. Laying hens were fed ad libitum with a standard commercial diet, whose average chemical composition is shown in Table 1. In both experimental groups water was also available ad libitum.

Fifteen eggs per group were collected for analysis at 32 weeks of hen's age. These samples (eggs were one day old) were evaluated for selected external, internal and eggshell quality parameters and basic chemical composition.

- Egg weight was measured on an electronic scale with an accuracy of 10^{-2} g.

- Egg shape index, or short-axis to long-axis length ratio (%), was determined using a special device (B.V. Apparatenfabriek van Doorn, Holland).
- Albumen height was determined by a tripod micrometer (AMES, USA).
- Haugh units were calculated according to the following formula:
- HU=100log (H+7.57-1.7M0.37)
  where H = albumen height, mm. M = egg weight, g.
- Egg yolk colour was determined according to the Roche yolk colour fan.
- Shell strength was tested with an Egg Crusher made by Pavlovski and Vitorović (1996).

Table 1. The chemical composition of diet for laying hens

Chemical composition	%
Dry matter	88.38
Crude proteins	16.79
Crude fats	5.15
Cellulose	4.82
Ash	12.52
Ca	3.72
Total P	0.71
Na	0.17
Lysine	0.79
Methionine+cystine	0.68
Metabolisable energy (MJ)	11.5 MJ

The analysis of the chemical composition of eggs was performed based on AOAC procedures (AOAC, 1990).

Egg quality data were analysed by ANOVA (Stat Soft Inc Statistica for Windows. Version 7.0., 2006).

Results and discussion

The results concerning the effect of laying hen genotype on selected egg quality parameters are presented in Table 2. As can be observed from the data, eggs produced by the Isa Brown hybrid exhibited a significantly higher egg weight compared to the New Hampshire breed ($p \leq 0.05$). Comparable findings, indicating that genotype exerts a decisive effect on egg weight, have been

reported by Rakonjac et al. (2021), Calik and Obzrut (2023), Dikmen et al. (2025), and Boubekeur and Souddi (2026).

Isa Brown hens produced rounder eggs than New Hampshire ($p \leq 0.01$). Škrbić et al. (2011) also found that native breeds produced "pointier" eggs as compared to hybrid hens. A significant effect of genotype on the egg shape index was also determined by Ledvinka et al. (2012), Kraus and Zita (2019) Rakonjac et al. (2021) and Dikmen et al. (2025).

The data presented in Table 1 indicate that there were no significant differences in albumen height or Haugh units between the examined genotypes ($p \geq 0.05$). The absence of significant differences in this trait was also reported by Škrbić et al. (2020) between Banat Naked Neck and Svrljig Hen. However, a greater number of authors have reported a significant effect of genotype on these parameters, including Rakonjac et al. (2021) and Dikmen et al. (2025).

The yolk of the New Hampshire genotype was more intensely colored than that of Isa Brown hens ($p \leq 0.05$). A significant effect of genotype on yolk color was also reported by Kucukyilmaz et al. (2012), who found higher Roche scores in ATAK-S hens compared to Lohmann LSL. Similarly, Calik and Obzrut (2023) attributed differences in yolk pigmentation to genetic factors in their study involving Rhode Island Red and Rhode Island White genotypes.

The Isa Brown hybrid exhibited superior shell quality compared to the New Hampshire breed, resulting in significantly higher shell breaking strength ($p \leq 0.05$). Greater shell breaking strength in Isa Brown hens compared to New Hampshire was also reported by Rakonjac et al. (2021). A significant influence of genotype on this trait was likewise documented by Zita et al. (2009) and Calik and Obzrut (2023).

Table 2. The effect of the laying hen's genotype on selected egg quality parameters

Traits	Genotype	
	Isa Brown	New Hampshire
Egg weight (g)	61.19±3.15 a	57.43±3.56 b
Egg shape index	78.93±2.63 a	75.67±1.91 b
Albumen height (mm)	7.85±1.12	8.04±0.83
Haugh unit	83.73±5.97	89.40±4.72
Yolk colour (Roche)	8.87±0.92 b	10.47±0.83 a
Shell strength (N)	43.35±7.09 a	35.82±6.61 b

a-b: Values within rows with different superscripts are significantly different ($p \leq 0.05$)

Table 3 presents the effect of genotype on key parameters of egg chemical composition. As shown, the only significant difference was observed in lipid content, while no significant differences were detected in dry matter, mineral, or protein content. The absence of significant differences in protein and mineral content is consistent with López et al. (2016), and protein content ($p \geq 0.05$) aligns with the findings of Rizzi and Chiericato (2010), who reported no significant variation among three genotypes - Hy Line White, Hy Line Brown, and Robusta Maculata.

Table 3. The effect of the laying hen's genotype on chemical composition of eggs

Traits	Genotype	
	Isa Brown	New Hampshire
Dry Matter (%)	23.75±1.11	23.89±0.89
Minerals (%)	0.85±0.05	0.87±0.04
Protein (%)	12.33±0.70	12.35±0.30
Lipids (%)	8.61±0.79 b	9.16±0.90 a

a-b: Values within rows with different superscripts are significantly different ($p \leq 0.05$)

New Hampshire hens had higher total lipid content in eggs ($p \leq 0.05$) compared to Isa Brown. Similarly, Rakonjac et al. (2021) reported higher yolk lipid content in New Hampshire eggs ($p \leq 0.05$). Furthermore, Pintea et al. (2012) observed significant differences in yolk lipid content between the Araucana breed and the Isa Brown hybrid, highlighting the influence of genotype on egg lipid composition.

Conclusion

Overall, eggs produced by Isa Brown laying hens were characterized by greater egg weight, higher shape index, and superior shell breaking strength, whereas eggs from the New Hampshire breed exhibited more intensely pigmented yolks. No significant differences were observed between the genotypes with respect to albumen height or Haugh units.

Concerning egg chemical composition, significant differences were identified only in lipid content. Eggs from the New Hampshire breed contained a higher proportion of lipids compared to those from the Isa Brown genotype. In contrast, no significant differences were detected in dry matter, mineral, or protein content between the examined genotypes.

Acknowledgement

The research presented in this article is part of No. 451-03-33/2026-03/ 200088 and 451-03-33/2026-03/ 200022 financially supported by Ministry of Science, Technological Development and Innovation of Republic of Serbia.

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