

EFFECT OF PEA PROTEIN ON BROILER PERFORMANCE

Lukáš Čumplík, Jakub Novotný, Dana Zálešáková,
Izabela Helena Neradová, Lenka Kudlová, Ondřej Šťastník

*Department of Animal Nutrition and Forage Production,
Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1,
Czech Republic*

Corresponding email address: lukas.cumplik@mendelu.cz

ABSTRACT

The aim of this experiment was to investigate the effect of incorporating pea protein into broiler diets on growth, feed intake, feed conversion, yield, and the parameters of the main meat cuts. Pea protein was incorporated into the diets as a substitute for soybean meal. The cultivation of soybeans and their import into Europe currently appear problematic from an environmental perspective; therefore, alternative protein sources are being sought to reduce the use of soybeans in animal diets. The experiment included 128 Ross 308 broilers, which were fattened for 36 days. Four groups were formed—a control group (K) and three experimental groups, which were fed a diet containing pea protein that replaced soybean meal at levels of 25 % (H25), 50 % (H50), and 100 % (H100). The highest slaughter weight was recorded in the H50 group, at 2,179 g, while the lowest slaughter weight of 1,715 g was found in the H100 group ($P < 0.05$). Likewise, the highest average weight gain was observed in the H50 group, and the lowest average weight gain in the H100 group ($P < 0.05$). Neither feed intake nor feed conversion was affected by the inclusion of pea protein in the broiler diets ($P > 0.05$). In the H100 group, there was a decrease in yield compared to the other groups ($P < 0.05$) as well as a reduction in breast weight, which was also reflected in the breast percentage of slaughter weight ($P < 0.05$). Conversely, the lowest proportion of thighs in broiler body weight was measured in the H50 group and the highest in the H100 group ($P < 0.05$). The results indicate that incorporating pea protein into broiler feed formulations is feasible and may even have a positive effect on certain production parameters. However, replacing soybean meal with pea protein in the diets may impair growth and broiler carcass quality parameters.

Keywords: alternative protein source; carcass; fattening; animal nutrition; poultry; Ross 308



INTRODUCTION

Sustainability and reducing the negative impact of human activity on the environment are increasingly discussed topics today. The agricultural sector, and specifically livestock production, is closely linked to these issues. Feed is the most costly item in livestock farming. In poultry farming, this cost item accounts for 70–75 % of total costs (Mbukwane *et al.*, 2022), which only underscores its financial burden on the operation. Soy is an irreplaceable protein feed in the diet of non-ruminants. However, from today's perspective, it may seem rather “controversial” precisely from an environmental standpoint. The deforestation of rainforests to expand soybean croplands, coupled with costly imports to Europe that consume significant amounts of fossil fuels, increases the pressure to find alternatives to reduce the consumption of this feed (Te Pas *et al.*, 2021; Pexas *et al.*, 2023). Feed selection should therefore not be solely a matter of cost or nutritional quality; the environmental impact is also coming to the forefront (Thornton *et al.*, 2023). One way to reduce the negative environmental impact is to increase the proportion of locally sourced feed. In 2024, global soybean production totaled 397 million tons, with 86.2 % grown in South America. Europe accounted for only 2.7 % of global production, as 8 million tons of soybeans were grown there. However, soybean cultivation continues to intensify. Over the past 50 years (1974–2024), production has increased nearly eightfold. Insects, seaweed, or legumes are mentioned as alternative protein feeds that could at least partially replace soy (Čumplík *et al.*, 2026). Peas are also one of the possible alternatives. Although dry pea production amounted to 14 million tons in 2024, Europe accounted for less than 54 % of it; specifically, 6 million tons of peas were grown in Europe (Faostat, 2026). The local availability of peas in European conditions may play an important role in the future when selecting protein feeds for diets not only for broilers but for livestock in general.

MATERIAL AND METHODS

A total of 128 male Ross 308 broiler chickens were monitored as part of the experiment; they were fattened for a period of 36 days. The broilers were reared in accredited cage systems in the experimental rearing halls of building M at Mendel University in Brno. The broilers were housed in groups of 8 in 16 cages. Each group consisted of 4 repetitions. Feeding of the broilers and simultaneous data collection took place regularly at the same time to ensure that the results obtained were as objective as possible. Over the course of 36 days, the broilers were fed 3 types of diets (starter diet, grower diet, and finisher diet) to adhere to phase-specific nutrition. The component composition of diets is shown in Tables 1, 2, and 3. The diets contained varying proportions of pea protein. The nutritional composition of the pea protein is shown in Table 4. The control mixture did not contain pea protein (K). In the first experimental mixture, 25 % of the soybean meal was replaced with pea protein (H25); in the second experimental mixture,

50% of the soybean meal was replaced with pea protein (H50); and in the third experimental mixture, 100% of the soybean meal was replaced with pea protein (H100). The diets were analyzed to determine the content of basic nutrients—dry matter, crude protein, crude fat, crude fiber, and crude ash. The results of the chemical analysis of the diets are presented in Table 5. During the experiment, broiler performance—weight gain, feed intake, and feed conversion ratio—was monitored. The health status of the chickens will also be monitored based on the performance data, clinical assessment, and mortality rate. Light, temperature, and humidity conditions will be set according to the technical guidelines for Ross 308 (Aviagen, 2025). On day 36, the chickens were slaughtered by decapitation, and the carcasses were subsequently evaluated. Data obtained during the experiment were statistically analyzed using one-way analysis of variance in Statistica 14. For evaluated differences between groups was used the Sheffé's test and $P < 0.05$ was a significance level determinate statistically significant difference.

Tab. 1: *Feed components of starter diet*

COMPONENTS (%)	TREATMENTS			
	K	H25	H50	H100
Corn	30.00	36.13	37.50	48.50
Wheat	25.99	24.00	26.70	25.00
Soybean meal	35.00	27.00	18.30	X
Rape oil	5.00	4.80	5.32	5.33
Premix	3.00	3.00	3.00	3.00
Lysine	0.16	0.14	0.12	0.05
Methionine	0.22	0.23	0.23	0.25
Pea protein	X	4.00	8.00	17.00

K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

Tab. 2: *Feed components of grower diet*

COMPONENTS (%)	TREATMENTS			
	K	H25	H50	H100
Corn	37.77	33.03	42.60	47.40
Wheat	24.50	33.40	26.90	30.00
Soybean meal	29.60	22.30	14.80	X
Rape oil	4.82	4.95	5.40	5.30
Premix	3.00	3.00	3.00	3.00
Lysine	0.13	0.14	0.09	0.05
Methionine	0.18	0.19	0.21	0.25
Pea protein	X	3.00	7.00	14.00

K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

Tab. 3: Feed components of finisher diet

COMPONENTS (%)	TREATMENTS			
	K	H25	H50	H100
Corn	39.20	42.64	43.28	42.69
Wheat	29.00	28.55	30.23	37.45
Soybean meal	23.40	17.40	12.90	X
Rape oil	5.00	5.00	5.20	5.50
Premix	3.00	3.00	3.00	3.00
Lysine	0.22	0.21	0.19	0.16
Methionine	0.18	0.20	0.20	0.20
Pea protein	X	3.00	5.00	11.00

K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

Tab. 4: Nutritional composition of the pea protein (%)

	Dry matter	Crude ash	Crude protein	Crude fat	Crude fiber
Pea protein	88.00	4.09	70.68	0.31	0.29

Tab. 5: Chemical analysis of the diets at 88 % dry matter (%)

	Crude ash	Crude protein	Crude fat	Crude fiber
Starter diet				
K	6.48	19.83	6.32	2.59
H25	5.95	19.44	6.16	2.45
H50	5.61	19.35	6.83	2.14
H100	4.68	18.65	7.15	1.64
Grower diet				
K	5.65	18.16	6.64	4.04
H25	5.24	17.66	6.90	3.81
H50	4.66	17.15	7.09	2.09
H100	3.90	16.72	6.99	1.79
Finisher diet				
K	5.09	16.28	6.63	4.17
H25	4.80	16.16	6.77	3.91
H50	4.57	16.06	7.11	4.00
H100	3.75	16.23	7.22	3.93

K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

RESULTS AND DISCUSSION

By the end of the starter period (1–14 days of age), significant differences in body weight were already observed between the individual groups ($P < 0.05$). Broilers from groups K and H100 had significantly lower body weights than those from groups H25 and H50. The highest live weight was measured in group H25 (399 g), though this difference was not statistically significant compared to group H50 ($P > 0.05$). At the end of the grower period (15–28 days of age), the same trend from the previous period continued. Here as well, lower live weights were measured for chickens from groups K and H100 ($P < 0.05$). However, the highest live weight was found in group H50 (1,300 g), though this was not statistically significant compared to group H25 ($P > 0.05$). At the end of the experiment (day 36 of the broilers' age), the highest slaughter weight was achieved by chickens from group H50 (2,179 g), though this was not statistically significant compared to group H25. As was the case throughout the experiment, the lowest weight was recorded in the H100 group (1,715 g), which also lagged behind the control group in terms of weight during the finisher period. Conversely, compensatory growth was observed in the K group during the final phase of fattening. According to the technical guidelines for the Ross 308 hybrid (Aviagen, 2022), broilers should reach a live weight of 2,552 g by 36 days of age. The body weight of broilers in different fattening periods is shown in Table 6. On the contrary, the study by Kirn *et al.* (2024) states that up to 30 % inclusion of peas in the feed ration of broilers does not lead to lower performance. Similarly, the inclusion of pea hulls in a proportion of 4.5 % or pea protein concentrate in a proportion of 10 % did not negatively affect the slaughter weight of broilers. Laudadio and Tufarelli (2011) also state that up to 40 % inclusion of peas in diets did not worsen growth, feed consumption, or feed conversion. Dotas *et al.* (2014) even state that a proportion of 48 % peas in the diet had no effect on the growth of broilers.

Tab. 6: Body weight of broilers in different fattening periods (g)

PERIOD	TREATMENTS				SEM	P-VALUE
	K	H25	H50	H100		
Starter (14-day)	318 ^b	399 ^a	397 ^a	283 ^b	8.00	0.00
Grower (28-day)	1,118 ^b	1,294 ^a	1,300 ^a	1,011 ^b	21.92	0.00
Finisher (36-day)	1,897 ^{bc}	2,111 ^{ab}	2,179 ^a	1,715 ^c	33.63	0.00

^{a,b,c} means statistically significant differences ($P < 0.05$), SEM – Standard Error Mean, K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

The effect of pea protein on feed intake and feed conversion ratio was not evident in the final data for the entire fattening period (1–36 days of age) ($P > 0.05$). In contrast, a statistically significant difference was observed in body weight gain ($P < 0.05$). These results mirror the trend observed for body weight at 36 days of age. Here as well, the highest body weight gain was achieved by chickens in the H50 group (2,141 g) and the lowest by the H100 group (1,676 g). These results confirm that the slaughter weight of the chickens was not influenced by their initial live weight at placement. According to the technical guidelines for the Ross 308 hybrid (Aviagen, 2022), at 36 days of age, feed intake should be 200 g and the feed conversion ratio 1.408. Feed intake, feed conversion ratio, and body weight gain of the broilers are shown in Table 7. According to a study by Kirn *et al.* (2024), the inclusion of pea protein concentrate in the broiler diet at a rate of 10% did not lead to a deterioration in the feed conversion ratio. On the contrary, a deterioration in this parameter occurred when pea hulls were included in the diet at levels of 3% and 4.5%. Dotas *et al.* (2014) report that even a 48% proportion of peas in the diet does not lead to a reduction in feed intake or a deterioration in feed conversion.

Tab. 7: Feed intake, feed conversion ratio, body weight gain

	TREATMENTS				SEM	P-VALUE
	K	H25	H50	H100		
Feed intake per broiler (g)	107	98	103	97	2.43	0.47
Feed conversion ratio	2.1	1.7	1.7	2.1	0.08	0.11
Body weight gain (g)	1,859 ^{bc}	2,072 ^{ab}	2,141 ^a	1,676 ^c	53.84	0.00

^{a,b,c} means statistically significant differences ($P < 0.05$), SEM – Standard Error Mean, K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

Replacing 100% of soybean meal with pea protein had a negative effect on carcass quantitative parameters, as shown in Table 8. The H100 group had the lowest carcass weight (1,176 g) and the lowest breast weight of all groups (123 g) ($P < 0.05$). Conversely, the inclusion of pea protein had no effect on thigh weight ($P > 0.05$). Similarly, the proportion of breast weight relative to live weight was lowest in the H100 group (14.04%), with the highest proportion recorded in the H25 group (19.09%) ($P < 0.05$). Conversely, the proportion of thigh weight was highest in the H100 group (14.71%) and lowest in the H50 group (12.92%) ($P < 0.05$). According to the study by Kirn *et al.* (2024), it does not lead to a reduction in the proportion of breast or thigh meat in the carcass. Laudadio and Tufarelli (2011) add that even 40% peas in the broiler diet do not have a negative effect on the proportion of monounsaturated and polyunsaturated fatty acids or on the n-6/n-3 ratio.

Tab. 8: Quantitative parameters of carcass

	TREATMENTS				SEM	P-VALUE
	K	H25	H50	H100		
n	8	8	8	8	-	-
Body weight (g)	2,040 ^a	2,233 ^a	2,248 ^a	1,752 ^b	45.04	0.00
Carcass (g)	1,392 ^a	1,556 ^a	1,561 ^a	1,176 ^b	34.66	0.00
Breast (g)	182.9 ^a	213.1 ^a	197.9 ^a	123.0 ^b	7.25	0.00
Thigh (g)	137.0	150.0	145.1	128.9	2.91	0.05
Breast meat (% from BW)	17.77 ^a	19.09 ^a	17.61 ^a	14.04 ^b	0.40	0.00
Thigs meat (% from BW)	13.38 ^{ab}	13.46 ^{ab}	12.92 ^b	14.71 ^a	0.21	0.01

n – number of samples, ^{a,b} means statistically significant differences ($P < 0.05$), SEM – Standard Error Mean, BW – body weight, K – control group, H25 – 25 % soybean meal replaced with pea protein, H50 – 50 % soybean meal replaced with pea protein, H100 – 100 % soybean meal replaced with pea protein

CONCLUSION

This study has shown that the inclusion of pea protein in diets for broilers is possible. In this way, the use of soybean meal can be reduced by 50 % in diets for Ross 308 broilers. However, it is necessary to add that according to our results, soybean meal cannot be fully replaced by pea protein. Complete replacement leads to a decrease in the intensity of broilers and can also negatively affect the quality of the carcass, especially by reducing the weight of the breast. However, partial replacement (25 and 50 %) of soybean meal with pea protein does not negatively affect the growth of individuals, but according to our results, it can even improve growth. The highest live weight gain was observed in the H50 group. As for the effect of the inclusion of pea protein on the carcass, 25 % and 50 % replacement of soybean meal does not negatively affect the yield, breast weight, thigh weight, or the proportion of breast weight in live weight. However, in the H50 group, a negative effect on the thigh weight parameter from the live weight fraction was observed. Our results indicate that at least 50 % replacement of soybean extracted meal with pea protein does not impair broiler performance.

As soybean is widely used as a protein source in animal nutrition, reducing its inclusion in feed formulations could contribute to a decrease in the intensity of soybean cultivation. Modifying the choice of dietary protein sources may help mitigate the environmental impacts associated with animal production. Furthermore, increased utilization of locally produced feed ingredients represents an additional strategy for reducing the pressure on tropical deforestation and lowering fossil fuel consumption associated with feed transportation. Therefore, the identification and adoption of alternative protein sources constitute important steps toward enhancing the sustainability of agricultural production systems.

ACKNOWLEDGEMENT

The project was supported by the Internal Grant Agency of the Faculty of Agronomy, Mendel University in Brno, through the project IGA26-AF-IP-041 (Náhrada sójového extrahovaného šrotu v dietách pro brojlerý hrachovým proteinem).

REFERENCES

- Aviagen (2025): Broiler Handbook – New & Interactive. Available from https://aviagen.com/assets/Tech_Center/Ross_Broiler/Aviagen-ROSS-Broiler-Handbook-EN.pdf (accessed Jun 12, 2025).
- Aviagen (2022): Ross 308/308 FF broiler: Performance objectives. Available from https://aviagen.com/assets/Tech_Center/Ross_Broiler/RossxRoss308-BroilerPerformanceObjectives2022-EN.pdf (accessed Jun 12, 2025).
- Čumplík L., Zálešáková D., Novotný J., Kudlová L., Pavlata L., Šťastník O. (2026): Alternative protein sources in poultry and pig nutrition—A review. *Journal of Animal Physiology and Animal Nutrition*, 110: 351–367. Available from <https://doi.org/10.1111/jpn.70047>
- Dotas V., Bampidis V.A., Sinapis E., Hatzipanagiotou A., Papanikolaou K. (2014): Effect of dietary field pea (*Pisum sativum* L.) supplementation on growth performance, and carcass and meat quality of broiler chickens. *Livestock Science*, 164: 135–143. Available from <https://doi.org/10.1016/j.livsci.2014.03.024>
- Faostat (2026): Crops and livestock products. Food and Agriculture Organization of the United Nations. Available from <https://www.fao.org/faostat/en/#data/QCL/visualize> (accessed Jun 2, 2026).
- JAOCS, Journal of the American Oil Chemists' Society, 88: 967–973. Available from <https://doi.org/10.1007/s11746-010-1742-3>
- Kirn A.I., Vahjen W., Weindl P.A., Hofmann P., Zentek J., Bellof G. (2024): Effect of peas and pea products in diets for broiler chickens with consideration of the intestinal microbiota. *Journal of Applied Poultry Research*, 33(2). Available from <https://doi.org/10.1016/j.japr.2023.100401>
- Laudadio V., Tufarelli V. (2011): Pea (*Pisum sativum* L.) seeds as an alternative dietary protein source for broilers: Influence on fatty acid composition, lipid and protein oxidation of dark and white meats.
- Mbukwane M.J., Nkukwana T.T., Plumstead P.W., Snyman N. (2022): Sunflower Meal Inclusion Rate and the Effect of Exogenous Enzymes on Growth Performance of Broiler Chickens. *Animals*, 12(3). Available from <https://doi.org/10.3390/ani12030253>
- Pexas G., Doherty B., Kyriazakis I. (2023): The future of protein sources in livestock feeds: implications for sustainability and food safety. *Frontiers in Sustainable Food Systems*, 7: 1–13. Available from <https://doi.org/10.3389/fsufs.2023.1188467> (accessed Jun 12, 2025).

- Te Pas M.F.W., Veldkamp T., De Haas Y., Bannink A., Ellen E.D. (2021): Adaptation of livestock to new diets using feed components without competition with human edible protein sources—A review of the possibilities and recommendations. *Animals*, 11(8). Available from <https://doi.org/10.3390/ani11082293>
- Thornton P., Gurney-Smith H., Wollenberg E. (2023): Alternative sources of protein for food and feed. *Current Opinion in Environmental Sustainability*, 62: 101277. Available from <https://doi.org/10.1016/j.cosust.2023.101277>