Agronomy Research **15**(4), 1550–1558, 2017
https://doi.org/10.15159/AR.17.008

Evaluation of nutritional and physical values of pellets based on pea and lupine with added yeast in chickens fattening

L. Chladek[1,*], V. Plachy[2], P. Vaculik[1] and P. Brany[1]

[1]Czech University of Life Sciences Prague (CULS), Faculty of Engineering, Kamýcká 129, CZ165 21 Prague – Suchdol, Czech Republic
[2]Czech University of Life Sciences Prague, Faculty of Agrobiology, Food and Natural Resources, Department of Microbiology, Nutrition and Dietetics, Kamýcká 129, CZ165 21 Prague – Suchdol, Czech Republic
[*]Correspondence: chladekl@tf.czu.cz

Abstract. The article is focused on the development of the new type of broiler chicken feed, based on pea (*Pisum sativum L.*) and blue lupine (*Lupinus angustifolius L*), enriched with used dried brewer´s yeast. This composition eliminates use of soybean meal (PES) that was yet a traditional component in chicken feed. The main reason for its elimination was the using of genetically modified varieties of soybean and its relatively high price around 0.5 €uro kg^{-1} in Czech Republic. For milling of pea or blue lupine was used vertical (hammer) mill type Taurus, supplied by company TAURUS, for drying of used brewer´s yeast had been used drier Memmert UFE 800, final dry matter of the yeast was 88%. For pellets production were used two devices, press type JGE 120-6110 and Testmer. For the determination of physical properties of manufactured pellets (the weight of 1,000 pieces, bulk density, abrasiveness and pellet durability index PDI) were used following laboratory devices, Pellet Tester Holmen NHP and Testmer 200. Experimental activities had shown that the best results were reached using pellets manufactured on base blue lupine enriched by dried brewer´s yeast (6%).

Key words: broiler chicken, feeding, blue lupine (*Lupinus angustifolius*), pea (*Pisum sativum*), used dried brewery yeast, pellets, mechanical properties, weight of 1,000 pellets, bulk density, abrasiveness, pellet durability index (PDI).

INTRODUCTION

The global poultry industry has greatly expanded due to an increase in demand for chicken meat and eggs. Growth of the industry was followed by progress in research which resulted in improved growth rate, feed efficiency, health status, and reduced carriage of pathogens. However, major research focus was improvement in productivity. It is possible to manipulate feed formulations to improve the feed conversion ratio (FCR), which results in a lower feed requirement to achieve market weight. For improving of feed quality are used additives, which are ingredient or combination of ingredients added to the basic feed mix or parts thereof to fulfil a specific need. The problem of supplemental fats in broiler chickens feed discusses in his article V. Ravindran (Ravindran et al., 2006). Fats and oils possess the highest caloric density of all known nutrients. In recent years, because of the ever-increasing energy costs, there is greater interest in maximizing the use supplemental fats as nutritionists strive to increase the dietary energy density to meet the requirements of high-performing contemporary birds. To maximize their energy yielding potential, there is a need to better understand the physiological basis and factors affecting fat digestion. Compared to other macronutrients, the digestion and absorption of fats is a complex process and involve sequence of physicochemical events requiring breakdown to fat droplets, emulsification, lipolysis and micelle formation. Current knowledge of the principles of fat digestion and absorption in poultry is reviewed, along with factors influencing available energy content of supplemental fats (Cowieson, 2016). The supplemental fats are one of the most difficult ingredients to evaluate in terms of available energy. Important variables influencing the energy content of fats include age of the birds, degree of fat saturation, chain length, free fatty acids and fat inclusion level. Potential strategies to improve fat utilization in poultry diets are also examined (Gangadoo, 2016; Ravindran, 2016). Used brewery yeast is a waste from main fermentation of wort to get so called 'green beer' before lager process. From one hl of fermenting wort will be generated two liters of used yeast, but only one liter is possible to reuse it for next fermentation cycle. The brewery yeast has a stimulating effect, supports the immune system of animals, improving the digestibility of protein, eliminate diarrhea, improve skin development quality, also improve reproduction. The high biological value is determined by the favorable B-group vitamins, particularly thiamine (vitamin B1), riboflavin (vitamin B2), pyridoxine (vitamin B6) and pantothenic acid (vitamin B3), as well as the content of minerals and trace elements , especially P, K, Fe, Cu, Zn. Dried brewer's yeast are particularly suitable as feed in feed mixtures for high-animals, young animals (piglets, calves, chickens, small animals of all kinds), and recovering animals (Kunze, 2010). Brewer's yeast composition of its stimulating effect and supports the immune system of animals. On brewer's yeast must be regarded not only in terms of price in relation to nitrogen substances, but must also include significant content of vitamin B (Kunze, 2010). The possible use of RNA from brewery spent yeast for enrichment of cattle feed described Chládek et al. (2007).

MATERIAL AND METHODS

During the experimental work had been used in the assembly of complete feed mixtures prepared on the basis of the nutrient needs of fattened chickens created under wheat, pulses and dried brewer's yeast. As test animals used were chicken broiler ROSS 308, split into three groups of 100 pieces (two experimental groups and a third group that was fed conventional feed). The first mix was used as the basis blue lupine (*Lupinus angustifolius L.*) with the addition of 6% of dry yeast to increase the levels of nitrogen compounds, second group of broilers fed diets, whose foundation was pea (*Pisum sativum L.*) as a main proteinaceous component and to reach match levels of nitrogen compounds have been used 6% (mas) of dry yeast (Plavnik & Sklan, 1995; Elwinger et al., 2016). All chickens were fattened till the age of 46 days. The extension of the fattening period was chosen because of the use of the procedure in organic farming. Further combinations lupine or pea and yeast were not able to meet the nutritional needs of the protein for classical fattening.

Chickens fed with the addition of dry yeast into both types of feed were compared with a control group of comparable weight. Due to the content of the natural sources of amino acids, vitamins, especially B group and minerals in both groups fed yeast was detected yeasty taste adulteration meat quality without any symptom of the yeast taste. The results showed a possibility of substituting soybean meal by pea or lupine to get the same quality of meat produced by feeding soya bean.

For the preparation of broiler chicken feed had been as a raw material used blue lupine, pea and used dried brewer´s yeast. As test chicken for experimental activities had been used chicken broilers ROSS 308, split into two groups of 100 pieces, one group was fed with pea enriched by supplement of 6% dried yeast and second one was fed in similarly way by blue lupine enriched by 6% of dried yeast (Rutkowski, 2015). In the initial version of the article was published a wrong information about third group of fattening, this part of the article was deleted. (For this mistake we are sorry and thank to reviewer for his kind remind). Pea and blue lupine for feeding purposes had been harvested in School farm of CULS. For the milling of pea and lupine was used Vertical hammer mill type Taurus (Fig. 1), supplied by company TAURUS LTD Chrudim (Czech Republic) is the machine determined for milling of cereals. Material is milled by eight hammers as well as by friction between sieve and milled materials. The capacity of the mill is 200 kg h^{-1}. For the experimental activities was used sieve No. 3, giving on the base of previous trials the best results.

Spent yeast for pellets manufacturing had been provided by Tutorial and Research Brewery of the Czech University of Living Sciences (CULS) in Prague. The fresh yeast, type W96, was supplied by Research Institute of Malting and Brewing (RIBM) in Prague.

For the manufacture of pellets had been used pellet press JGE 120-6110 (Figs 2, 3 and 4) (capacity 100 kg h^{-1}), flowsheet capacity 200 kg h^{-1}. The used matrix had whole diameter 3 mm, the length of pellets was 6.5 mm. The second pellet press type Testmer 200 (Fig. 5) was equipped with the same matrix. For spent brewer´s yeast drying had been used drier type Memmert UFE 800, initial dry matter appr. 7%, final dry matter 93%.

Figure 1. Vertical hammer mill type TAURUS.

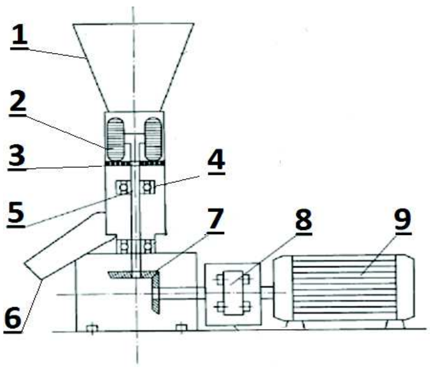

Figure 2. Flowsheet of pellet press JGE 120-6110. Explanatory notes: 1 – hopper, 2 – rollers, 3 – matrix, 4 – bearing, 5 – shaft, 6 – outlet of pellets, 7 – bevel gearing, 8 – flange coupling, 9 – electric motor.

Figure 3. Pictures of pellet press JGE 120-6110.

Figure 4. Matrix of pellet press JGE 120-6110 with wholes diameter 3 mm and 8 mm.

Figure 5. Picture of pellet press type Testmer 200, using the same matrix (wholes 3 mm).

Figure 6. Picture of device for abrasiveness measurement New Holmen Tester TEK (general view).

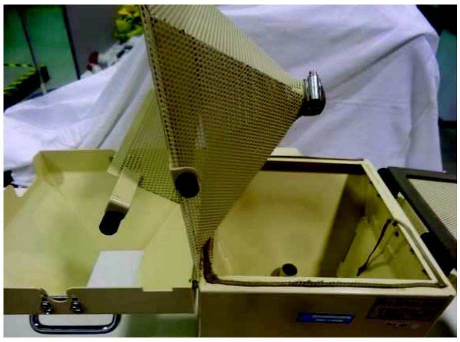

Figure 7. Picture of device for abrasiveness measurement New Holmen Tester TEK (detail).

For the measurement of the weight of 1,000 pellets, made from pea and from blue lupine had been used the balance type KERN 440-43, weighing range 0–400 g, accuracy ± 0.5 g (Fig. 12). For the measurement of abrasiveness and of mechanical durability index of developed chicken feed have been used two different laboratory devices. First one was Ligno-Tester LT II, designed according Austrian standard ÖNORM M7135, manufactured and supplied by Company Borregaard Lignotech, (Fig. 8).

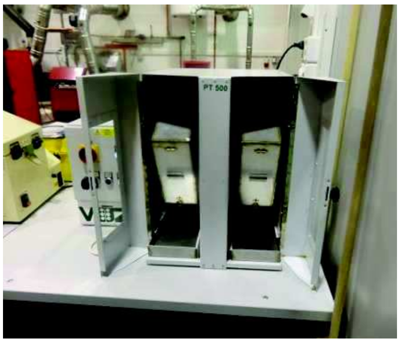

Figure 8. Picture of device type PT for pellets durability index measurement (PDI).

The flow sheet of this device is shown on the Fig. 11. The device consists of the housing with a pyramid sieve (tip down) in that is put before measurement weighed sample of the pellets. On the down part of sieve there is located an inlet of pressed air and the fan and outlet of tested pellets. The air passes through the layer of pellets generating their movement that causes their abrasiveness.

The weight of pellets after this process was weight of pellets again tested. The way of abrasiveness measurement was following: the mass 100 g ± 0.5 g of pellets was put into pyramid sieve in apparatus and let it blowing through the layer of pellets for 60 seconds by the air at pressure 70 mbar from the fan installed in apparatus. The final value of the pellets abrasiveness was calculated using following equation:

$$A = \frac{(mE - mA)}{mE} \cdot 100 \quad (1)$$

where A – abrasiveness (%); mE – initial weight of pellets before measurement (g); mA – final weight of pellets after measurement (g).

The second used device was designed according Czech standard ČSN EN 15210-1 'Determination of mechanical durability of pellets'. The picture of this device is shown on Fig. 11. The design of the device is following: it consists of two square or hexagonal boxes fixed on the rotating shaft. At the beginning of measurement every box will be filled with 500 g ± 10 g.

After closing the box starts to rotate at speed of fifty revolutions per minute. After 500 revolutions (appr. 10 minutes) content of every box will be sieved to separate generated dust, the remaining pellets will be weighed. The measured durability will be calculated according next equation:

$$PDI = \frac{mA}{mE} \cdot 100 \quad (2)$$

where PDI – Pellet Durability index (%); mE – initial weight of pellets before measurement (g); mA – final weight of sieved pellets after measurement (g).

The ratio between abrasiveness (Eq. 1) and PDI (Eq. 2) is following:

$$PDI = 100 - A \quad (3)$$

RESULTS AND DISCUSSION

Comparison of results using pea, lupine and yeasts for chicken feeding

The course of 46 days chicken feeding using feed blue lupine and pea without dried yeast is ilustrated in Fig. 9.

Fig. 9 illustrates average results from 10 trials showing increase in weight of living chicken during course of 46 days. With an exception of first 10 and 32 days better result have been reached using lupine (Table 1).

Table 1. Live weight of chicken

Feed	Lupine (g)	Pea (g)	Lupine (%)	Pea (%)
10 days	176	185	95.14	100
20 days	433	347	124.78	100
32 days	718	710	101.13	100
46 days	2223	2177	103.91	100

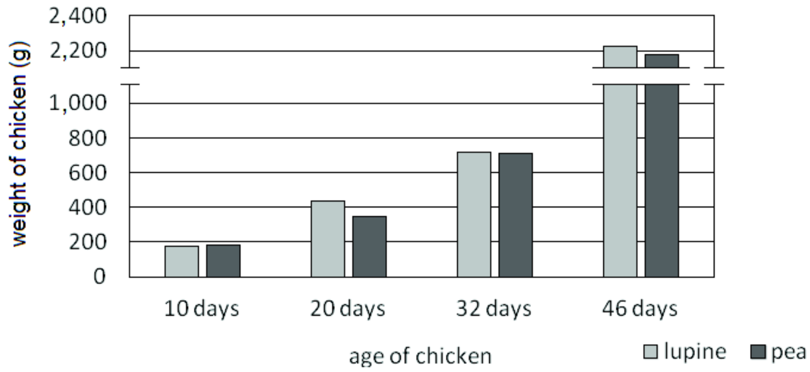

Figure 9. Increase in weight of chicken (g), fed blue lupine and pea (without dried yeast).

Fig. 10 illustrates feed conversion of broiler chickens using blue lupine or pea enriched by 6% of dried yeast (feed conversion means feed consumption (kg)/1 kg of increase in weight) (Table 2).

Table 2. Feed conversion (1–46 days)

		Lupine	Pea
Weight	(g)	1,846	1,900
	(%)	97.15	100

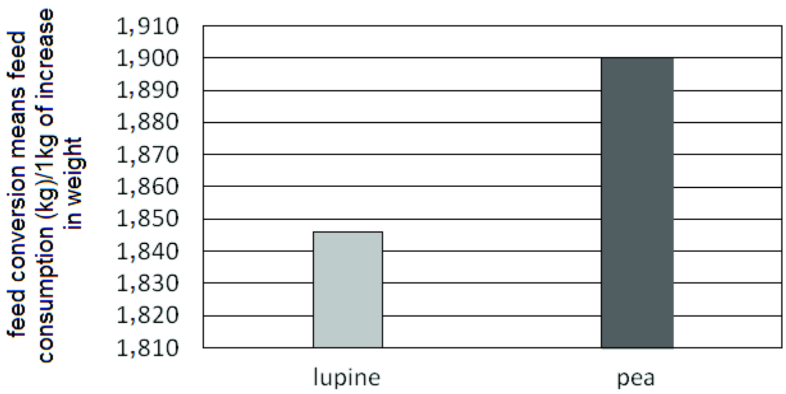

Figure 10. Feed conversion using supplement 6% of dried yeast.

Measurement of 1,000 pellets weight

The weighing of 1,000 pellets**,** made from pea and 6% dried yeasts, diameter 3 mm, lengths 6.5 mm.

Figure 11. Weighing of 1,000 pellets made from pea with addition of 6% dried yeast.

Figure 12. The weighing of 1,000 pellets, made from pea with addition of 6% dried yeast, diameter 3 mm, lengths 6,5 mm.

The average weight of 1,000 pcs lupine pellets was in the range 25.0–25.9 g, average mass of pea pellets was in the range the 27.9–28.1 g (Table 3 and 4). The difference in weight of pea and lupine pellets was caused by different content of fiber.

Table 3. Weight of 1,000 pieces of lupine pellets with addition of 6% dried yeast

Nr.	1	2	3	4	5	6	7	8	9	10
1	26.2	25.9	26.1	26.0	26.2	25.9	25.0	26.0	26.2	26.1
2	24.4	25.8	24.7	25.8	25.5	25.8	25.5	25.4	24.0	24.7
3	25.8	25.9	25.8	24.4	25.5	25.9	26.0	25.3	26.0	24.8
4	26.1	26.0	25.9	26.2	25.7	24.9	25.7	26.3	26.0	24.9
5	25.9	25.5	25.0	25.5	25.8	25.4	25.8	25.4	25.0	24.0
6	25.7	25.2	25.5	26.0	26.1	26.2	26.1	26.2	25.7	25.5
7	25.4	25.4	25.5	25.1	26.2	25.4	26.0	25.4	26.0	25.5
8	25.9	24.8	25.7	26.4	25.9	24.1	25.9	25.9	25.9	25.0
9	25.9	25.8	24.0	24.0	25.8	25.8	25.8	25.8	26.1	25.9
10	25.3	25.9	26.6	26.1	26.3	25.9	25.8	25.9	25.3	24.0
∑	256.6	256.2	254.8	255.5	259	262.1	264.6	265.6	265.2	260.4
Average	25.7	25.6	25.5	25.6	25.9	25.6	25.8	25.8	25.6	25.0
St. Error	1.93	1.44	2.77	2.99	1.06	1.64	1.17	1.34	2.53	2.72
St. Dev	0.50	0.37	0.71	0.76	0.28	0.42	0.30	0.34	0.65	0.68

Table 4. Weight of 1 000 pieces of pea pellets with addition of 6% dried yeast

Nr.	1	2	3	4	5	6	7	8	9	10
1	28.2	28.0	28.2	28.2	28.2	28.2	29.0	28.1	27.0	28.1
2	28.1	27.9	27.1	28.1	29.0	28.1	28.1	27.9	27.9	27.9
3	28.9	28.0	28.3	28.3	27.3	28.3	28.3	28.0	28.0	28.0
4	28.5	28.2	28.5	27.5	28.5	28.5	28.5	27.2	28.2	27.2
5	27.7	28.5	27.3	26.7	27.2	27.7	27.7	27.9	28.6	27.5
6	27.3	28.4	27.6	27.6	27.6	27.6	27.6	28.4	28.4	27.4
7	27.7	27.9	27.7	27.7	27.7	27.7	27.7	27.9	27.9	27.9
8	29.0	27.8	28.0	28.0	28.0	28.0	28.0	28.8	29.0	28.8
9	27.8	28.2	27.8	27.8	27.8	27.8	27.8	28.2	28.2	28.2
10	28.2	28.1	28.2	28.2	29.0	27.3	28.2	28.1	27.6	28.1
∑	281.4	281	278.7	278.1	280.3	279.2	280.9	280.5	280.8	279.1
Average	28.1	28.1	27.9	27.8	28.0	27.9	28.1	28.1	28.1	27.9
St. error	1.83	0.76	1.54	1.63	2.17	1.24	1.46	1.38	1.86	1.56
St. dev	0.52	0.21	0.43	0.45	0.61	0.35	0.41	0.39	0.52	0.43

Results of measurement of bulk density of pea and lupine pellets with 6% dried yeast

For measurement of bulk density of pea and lupine was used graduated cylinder volume 0.5 liter. The bulk density of lupine pellets with 6% dried yeast was measured in the range 346.2–351.2 g 0.5 L (692.4 g L^{-1}). The bulk density of pea pellets with 6% dried yeast was determined again from 10 trials in the range 356.2 g 0.5 L^{-1} – 372.3 g 0.5 L^{-1} (712.4 g L^{-1} – 744.6 g L^{-1}).

Results of measurement of abrasiveness and PDI of pea and lupine pellets with 6% dried yeast

The results of abrasiveness and PDI of pea and lupine pellets with 6% dried yeast are shown in the Table 5 and Table 6.

Table 5. Abrasiveness of lupine pellets and pea pellets (device New Holmen Tester TEK– Figs 6 and 7)

	Lupine pellets			Pea pellets		
Nr.	mA (g)	mE (g)	A (%)	mA (g)	mE (g)	A (%)
1	100	71.7	28.3	100	74.5	25.5
2	100	71.9	28.1	100	75.1	24.9
3	100	72.9	27.1	100	75.2	24.8
4	100	72.4	27.6	100	75.6	24.4
5	100	72.9	27.1	100	75.8	24.2
6	100	71.4	28.6	100	75.4	24.6
7	100	72.0	28.0	100	75.1	24.9
8	100	72.1	27.9	100	75.8	24.2
9	100	72.4	27.6	100	75.1	24.9
10	100	72.2	27.8	100	75.2	24.8
∑	1,000	721.9	278.1	1,000	752.8	247.2
Average	100	72.2	27.8	100	75.2	24.8

Table 6. PDI of lupine pellets and pea pellets (device PT)

Nr.	Lupine pellets			Pea pellets		
	mA (g)	mE (g)	PDI (%)	mA (g)	mE (g)	PDI (%)
1	500	358.5	71.7	500	370.5	74.1
2	500	359.5	71.9	500	376.0	75.2
3	500	364.5	72.9	500	376.5	75.3
4	500	362.0	72.4	500	380.5	76.1
5	500	364.5	72.9	500	385.5	77.1
6	500	357.0	71.4	500	387.5	77.5
7	500	360.0	72.0	500	384.0	76.8
8	500	360.5	72.1	500	381.0	76.2
9	500	362.0	72.4	500	380.5	76.1
10	500	361.0	72.2	500	381.0	76.2
∑	5,000	3,609.5	721.9	5,000	3803	760.6
Average	500	361.0	72.1	500	361.0	76.1

CONCLUSION

The combination of pulses and dried yeast can be used as a substitute for soybean meal, especially in cases of chicken production in a sustainable and organic agriculture. Compared combination lupine x yeast and yeast games x indicates better performance of fattening in favor of lupine.

Unlike the bulk density of the tested compounds (pea - lupine) was due to a higher proportion of fiber in the case of lupine. There was a fairly good agreement in the measurement of abrasiveness and PDI of pea and lupine pellets enriched with dried yeast.

REFERENCES

Cowieson, A.J., Ruckebusch, J.P., Knap, L., Guggenbuhl, N. & Fru-Nji, J. 2016. Phytate-free nutrition. A new paradigm in monogastric animal production. *Animal Feed Science and Technology* **9**(222), 180–189.

Elwinger, K., Fisher, C., Jeroch, H., Sauveur, B., Tiller, H. & Whitehead, C.C. 2016. A brief history of poultry nutrition over the last hundred years. *Worlds Poultry Science Journal* **72**(4), 701–720.

Gangadoo, S., Stanley, D., Hughes, R.J. & Moore, J.R. 2016. Pro,gress and prospects in poultry research. *Trends in Food Science & Technology* **58**, 115–126.

Chládek, L., Přikryl, M. & Zeman, J. 2007. The possibility of the use of RNA from brewery spent yeast for enrichment of cattle feed. *Conference Proceeding, 3rd International Conference TAE 2007*. CULS Prague, pp 178–181. ISBN 978-80-213-1668-3.

Kunze, W. 2010. *Technology Brewing and Malting. 4th completely updated edition*. VLB Berlin. pp. 418–455, ISBN 978-3-921690-64-2.

Plavnik, I. & Sklan, D. 1995. Nutritional effects of expansion and short time extrusion on feeds for broilers. *Animal Feed Science and Technology* **55**(3–4), 247–251.

Ravindran, V., Tancharoenrat, P., Zaefarian, F. & Ravindran, G. 2016. Fats in poultry nutrition: Digestive physiology and factors influencing their utilisation. *Animal Feed Science and Technology* **213**, 1–21.

Rutkowski, A., Kaczmarek, S.A., Hejdysz, M., Nowaczewski, S. & Jamroz, D. 2015. Concentrates made from legume seeds (Lupinus angustifolius, Lupinus luteus and Pisum sativum) and rapeseed meal as protein sources in laying hen diets. *Annals of Animal Science* **15**(1), 129–142.