Bulgarian Journal of Agricultural Science, 30 (No 4) 2024, 660–665

Effect of dietary probiotics and prebiotics on the growth performance and meat quality of Ile-de-France lambs

Ivan Slavov, Nikolay Ivanov* and Stayka Laleva

Agricultural Academy, Agricultural Institute, 6000 Stara Zagora, Bulgaria
**Corresponding author:* n_t_ivanov@abv.bg

Abstract

Slavov, I., Ivanov, N. & Laleva, S. (2024). Effect of dietary probiotics and prebiotics on the growth performance and meat quality of Ile-de-France lambs. *Bulg. J. Agric. Sci., 30*(4), 660–665

The research study was conducted in the sheep farm of the Agricultural Institute – Stara Zagora. It included 45 Ile-de-France lambs divided into three groups with 15 animals each: one control and two experimental.

The lambs from experimental group I were individually supplemented with 8 g Immunobeta prebiotic on a daily basis, whereas lambs from experimental group II received the same amount of prebiotic plus 4 g Zoovit probiotic.

The following parameters were monitored – live body weight at the beginning and the end of the experiment, daily weight gain and slaughter age in days. The experiment lasted until a live weight of 23–25 kg was attained. Then 5 male lambs from each group were slaughtered, samples from *musculus Longissimus Lumborum* were collected and meat chemical composition and technological properties were analyzed.

It was demonstrated that the weight gain of lambs from experimental group I was by 21.74% ($P \leq 0.01$) higher, and that of lambs from experimental group II: by 17.39% ($P \leq 0.01$) higher compared to controls. Both supplemented groups attained slaughter live weight over a shorter period compared to the control group ($P \leq 0.001$). The meat WHC was lower in the two experimental groups vs controls, indicating that the loss of moisture from m. LL meat in these groups was higher than that of controls. In summary, the study allowed concluding that the dietary supplementation of lambs with 8 g Immunobeta prebiotic and 4 g Zoovit probiotic + 8 g Immunobeta prebiotic had a beneficial effect on the growth performance of animals.

Keywords: Ile de France; probiotics and prebiotics; meat quality

Introduction

The use of antibiotics in livestock husbandry dates back to more than a century (Kumar et al., 2020), both for treatment or prevention of various illnesses and with non-therapeutic purposes (Khare et al., 2018; Berge et al., 2005; Dibner & Richards, 2005). The emergence of antimicrobial resistance consequently to the non-prudent use of antibiotics (Humayun Kober et al., 2022; Urban-Chmiel et al., 2021; Kumar et al., 2020; Vidovic & Vidovic, 2020; Khare et al., 2018; Economou & Gousia, 2015) and the ban for application of antibiotics in the EC as growth promoters has necessitated a quest of their alternatives. According to literature data, various biologically active substances (probiotics, prebiotics, synbiotics and postbiotics) are some of growth promoting alternatives of antibiotics (Zhou et al., 2023; Khare et al., 2018; Adhikari & Kim, 2017).

The term "probiotic" was first introduced by Parker (1974). The definition of FAO and WHO for probiotics says that they are "live microorganisms that, when administered in adequate amounts, confer a health benefit on the host". The definition is approved by the International Scientific Association for Probiotics and Prebiotics (ISAPP) in 2013 (Hill et al., 2014). Probiotics are live microbial additives beneficial for the host through improvement of microbial balance of its intestinal tract. The term "probiotic" means literally

"for life" contrary to that of antibiotic: "against life" (Khare et al., 2018).

Gibson and Roberfroid (1995) defined prebiotics as „nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improve host health". FAO/WHO determines prebiotics as non-viable food components that confer a health benefit on the host associated with modulation of the microbiota (Pandey et al., 2015). The authors affirm prebiotics as a group of various carbohydrate components with poorly understood origin, fermentation profiles and effective doses with respect to host microbiota.

Probiotics and prebiotics modulate the balance and activity of gastrointestinal microbiota and may be used as functional foods (Uyeno et al., 2015). The authors further stated that the most frequently used probiotics are lactic bacteria strains from the *Lactobacillus, Enterococcus* and *Bifidobacterium* genera. Among prebiotics, carbohydrate substrates, e.g. oligosaccharides or poorly digestible dietetic fibres are the most commonly used (Uyeno et al., 2015). Through various mechanisms, both prebiotics and probiotics as dietary components improve intestinal health, immune system function and the growth performance of animals (Adhikari & Kim, 2017).

According to numerous researchers, probiotics reduce morbidity and mortality rates in animals, increase weight gain and slaughter yields and have a positive effect on pork and lamb quality (Liu et al., 2022; Al-Shawi et al., 2020; Dimova et al., 2013; Antunovic et al., 2006; Jukna et al., 2005).

The aim of the present study was to evaluate the effects from dietary supplementation of Ile-de-France lambs with the Immunobeta prebiotic and the combination of Zoovit probiotic + Immunobeta prebiotic with regard to growth performance and *musculus Longissimus Lumborum (m. LL)* meat quality.

Material and Methods

The experiments were performed in the sheep farm of the Agricultural Institute, Stara Zagora, Bulgaria with 45 Ile-de-France lambs (IlF) divided into 3 groups of 15 animals each – one control and two experimental. The three groups were with similar initial live body weight, sex ratio and birth type.

All lambs were reared in group boxes supplied with feeders for hay and concentrate and drinkers with constant access to fresh tap water as stipulated by Ordinance No 40 on the conditions for raising of agricultural animals, considering their physiological and behavioural characteristics. The lambs were fed *ad libitum* (+ 5 to 10% residue) a ration corresponding to their age that met all requirements for nutrients and biologically active substances. The ration included concentrate and alfalfa hay (Table 1).

Table 1. Compound feed composition for feeding IlF lambs

Ingredients	%
Soybean meal	4.00%
Limestone	3.00%
Salt	0.50%
Wheat	42.00%
Premix -16-97-K	0.20%
Sunflower meal	20.00%
Maize	30.30%

The compound feed contained 15.90% protein, 5.43% fibre, 2.40% fat, 1.12 units for growth and 2778.25 Kcal/kg energy.

The animals from experimental group I were individually supplemented once daily with 8 g prebiotic Immunobeta, and those from experimental group II: with the same amount of the prebiotic plus 4 g probiotic Zoovit.

The following parameters were monitored – live body weight at the beginning and the end of the experiment, daily weight gain and slaughter age of lambs in days. The trial lasted until a live weight of 23–25 kg was attained. After that, 5 male lambs from each group were slaughtered in a licensed slaughterhouse in the Stara Zagora region observing all requirements for humane handling of animals during transport and slaughtering according to Ordinance No 26 on the conditions for the protection and welfare of animals during their transport and Ordinance No 22 on minimisation of animal suffering during slaughter or killing. The slaughter live weight, hot carcass weight and slaughter yield were determined. The slaughter carcass was cut into two parts and the weight of the left half was measured. Samples from *m. LL* were collected from all animals, transported in a cool bag, stored at 0–4°C and analysed within 24 h post slaughter. The chemical composition and technological properties of meat samples were analysed. Meat pH was measured on Testo 205 pH-meter. The water holding capacity (WHC) of meat was evaluated by the classical pressing method of Grau & Hamm (1953). Cooking loss was determined by roasting a meat sample at 150°C for 20 min in a convection oven. Cooking loss percentage was calculated as the difference in sample weight prior to and after roasting. Meat tenderness was determined with DSD VEB Feinmess penetrometer (Dresden, Germany) and reported in penetrant degrees – °P. Meat colour was determined in the CIE L*a*b colour space. To this end, CIE L*a*b* coordinates were determined with Mi-

nolta CR400 colorimeter (Konica Minolta, Osaka, Japan) in D65 illuminant at 2-degree angle. The water content of meat was determined by drying in a dryer at 105°C as per BSS 15437:1982. The protein content of meat was determined as per BSS 9374:1982 by means of automatic Kjeldahl Distiller 149 VELP Scientifica, Italy. Fat content was determined by Soxhlet extraction as per BSS 8549:1992. Mineral content was determined by the method described in ISO 936:1998 after ashing meat samples in a muffle furnace.

The results were processed by STATISTICA for Windows with the t-test for independent samples.

Results and Discussion

Table 2 presents the data about the growth performance of IIF lambs fed concentrate ration supplemented with probiotics and prebiotics. The initial average live weight of control lambs was 8.43 kg, of the group supplemented with Immunobeta – 8.50 kg, and of the group that received Zoovit + Immunobeta – 8.17 kg. The live weight at the beginning of the experiment was as equal as possible, as did sex and birth type ratios. The highest live weight at the end of the experiment was recorded in experimental group II – 26.08 kg, whereas that of experimental group I and control group were 25.07 kg and 23.27 kg on the average. The final body weight of the two supplemented groups exceeded that of controls by 7.74% (experimental group I) and by 12.08% (experimental group II). The differences were not statistically significant. Hussein (2014), Antunovic et al. (2006) and Antunovic et al. (2005) also found out higher final live weight in probiotic-supplemented lambs compared to control lambs.

The average daily weight gain was the highest in lambs from experimental group I compared to untreated controls. The average daily weight gain was the highest in experimental group I – 0.28 g/day, followed by animals from experimental group II with 0.27 g/day; the lowest daily weight gain of 0.23 g/day was recorded in controls ($P \leq 0.01$). Our data corresponded to those reported by Hussein (2018) and Dimova et al. (2013). The average daily weight gain in experimental groups I and II was increased by 21.74% and 17.39% vs the control group. Control lambs attained the slaughter live weight after the longest time period – 97.33 days as compared to lambs from experimental groups I and II: 69.00 and 82.00 days ($P \leq 0.001$).

According to a number of authors, the addition of probiotics prevents digestive disorders in lambs (Abd El-Tawab et al., 2016; Ezema, 2013) which has a positive effect on weight gain and the final live weight of animals.

Data from Table 3 demonstrate that the highest average slaughter live weight of 26.08 kg was that of lambs from experimental group II and the controls had the lowest average live weight – 23.27 kg. The average slaughter live weight of experimental group I was 25.07 kg. The hot carcass weight was the highest in experimental group II, followed by lambs

Table 2. Growth abilities of IIF lambs supplemented with Immunobeta prebiotic and combination Zoovit probiotic and Immunobeta prebiotic

Parameters	Groups of animals						
	Control group -a		I experimental group -b		II experimental group -c		Significant
	n	$\bar{x}$±SD	n	$\bar{x}$±SD	n	$\bar{x}$±SD	
Live weight at birth, kg	5	3.83±1.61	5	5.50±0.50	5	3.38±0.76	NS
Live weight at start of experience, kg	5	8.43±1.37	5	8.50±0.50	5	8.17±1.61	NS
Live weight at the end of experience, kg	5	23.27±1.10	5	25.07±0.50	5	26.08±0.88	NS
Average daily growth, g/day	5	0.23±0.03	5	0.28±0.01	5	0.27±0.12	a:b**, a:c**
Age at slaughter, days	5	97.33±1.53	5	69.00±1.00	5	82.00±1.73	a:b***, a:c***

** – $P \leq 0.01$, *** – $P \leq 0.001$, NS – Not Significant

Table 3. Slaughter traits of IIF lambs, supplemented with Immunobeta prebiotic and combination Zoovit probiotic and Immunobeta prebiotic

Parameters	Groups of animals						
	Control group -a		I experimental group -b		II experimental group -c		Significant
	n	$\bar{x}$±SD	n	$\bar{x}$±SD	n	$\bar{x}$±SD	
Live weight before slaughter, kg	5	23.27±1.10	5	25.07±0.50	5	26.08±0.88	a:c*
Weight of warm carcass, kg	5	11.71±1.21	5	13.11±0.56	5	13.12±0.80	NS
Slaughter yield, %	5	50.25±4.05	5	52.30±1.17	5	50.29±1.54	NS
Weight of left half, kg	5	6.05±0.45	5	6.54±0.36	5	6.72±0.39	NS

* – $P \leq 0.05$, NS – Not Significant

from experimental group I and controls: 13.12 kg, 13.11 kg and 11.71 kg, respectively. The highest slaughter yield was established in lambs from experimental group I – 52.30%, whereas slaughter yields of controls and experimental group I were similar: 50.25% and 50.29%, respectively. The between-group differences of parameters listed in Table 3 were not statistically significant.

Data about the technological properties of *m. LL* are presented in Table 4. Meat pH values ranged within a narrow range, from 5.47 in experimental group II to 5.50 in experimental group I. The differences were inconsistent. Soumeh et al. (2021) and Chen et al. (2018) did not detect any changes in meat pH from broiler chickens and ducks, supplemented with probiotic and synbiotic. Similarly, Gomes et al. (2009) found no differences in the meat of ruminants supplemented with yeasts. The meat WHC varied among the three groups. In lambs from experimental group I average WHC was 19.25%, in experimental group II – 17.63%, and in controls: 12.32%. Therefore, moisture loss from m. LL in experimental groups I and II was greater than that of controls.

The difference between controls and experimental group I was significant at $P \leq 0.001$, whereas that between experimental group II and controls: at $P \leq 0.01$. With regard to meat colour, the colour coordinates values (L*, a* and b*) varied within a small range without statistically significant between-group differences. Hussein et al. (2020), Maiorano & Bednarczyk (2016) and Gomes et al. (2009) also detected no consistent differences in broiler and beef meat colour following dietary supplementation with probiotic. Liu et al. (2022) demonstrated that the intake of probiotics resulted in reduction of lamb L* values. According to our results, the lambs from experimental group I were outlined with the most tender meat – 322.20 °P, while the meat of controls and experimental group II had comparable average tenderness values: 286.56 °P and 286.40 °P respectively. The differences were not significant. Other researchers reported statistically significantly higher pork tenderness after dietary supplementation with probiotic (Gomes et al., 2009; Jukna et al.,2005). Cooking loss of *m. LL* samples varied within a narrow range and differences among the three groups were irrelevant.

The chemical composition of *m. LL* from lambs fed concentrate and supplemented with probiotics and prebiotics is shown in Table 5. Meat moisture values of *m. LL* in the control group and experimental groups I and II were similar: 76.92%, 76.99% and 77.05%. The protein content in meat also varied within a narrow range: 19.37%, 19.03% and 19.38% for controls, experimental groups I and II. Fat

Table 4. Technological properties of meat from *m. LL* of IIF lambs supplemented with Immunobeta prebiotic and combination Zoovit probiotic and Immunobeta prebiotic

Parameters		Groups of animals						
		Control group -a		I experimental group -b		II experimental group -c		Significant
		n	$\bar{x}$±SD	n	$\bar{x}$±SD	n	$\bar{x}$±SD	
pH_{24}		5	5.48±0.05	5	5.50±0.03	5	5.47±0.04	NS
WHC, %		5	12.32±2.22	5	19.25±3.24	5	17.63±3.62	a:b***, a:c**
Color	L^*	5	44.09±1.52	5	44.14±2.48	5	44.06±1.43	NS
	a^*	5	16.23±1.02	5	16.46±1.11	5	16.50±2.85	NS
	b^*	5	7.17±1.22	5	8.65±1.90	5	7.48±2.80	NS
Tenderness, °P		5	286.56±63.91	5	322.20±69.97	5	286.40±68.79	NS
Cooking loss, %		5	32.12±6.49	5	37.04±3.91	5	35.65±5.79	NS

** – $P \leq 0.01$, *** – $P \leq 0.001$, NS – Not Significant

Table 5. Chemical composition of *m. LL* from IIF lambs supplemented with Immunobeta prebiotic and combination Zoovit probiotic and Immunobeta prebiotic

Parameters	Groups of animals						
	Control group -a		I experimental group -b		II experimental group -c		Significant
	n	$\bar{x}$±SD	n	$\bar{x}$±SD	n	$\bar{x}$±SD	
Moisture, %	5	76.92±1.11	5	76.99±0.28	5	77.05±0.12	NS
Dry matter, %	5	23.08±1.11	5	23.01±0.27	5	22.95±0.12	NS
Protein, %	5	19.37±0.82	5	19.03±0.19	5	19.37±0.31	NS
Fat, %	5	2.51±0.33	5	2.91±0.37	5	2.31±0.54	NS
Minerals, %	5	1.20±0.20	5	1.07±0.10	5	1.27±0.15	NS

NS – Not Significant

content of meat was the highest in experimental group I – 2.91%, followed by controls (2.51%) and experimental group II (2.31%). Gomes et al. (2009) found no differences in beef fat content after yeast supplementation. Titi et al. (2008) demonstrated that yeast supplements reduced the protein content yet increased fat content of slaughter carcasses of Awassi lambs, and Shami kids. Raghebian et al. (2007) observed insignificantly higher meat fat and dry matter in the group supplemented with 3 g probiotic. Hamdon & Farghaly (2016) and Milewski & Zaleska (2011) also found out that animals supplemented with probiotic had statistically significantly higher meat fat content than non-supplemented controls. In this study, the registered average mineral content of meat in controls was 1.20% vs 1.07% for the probiotic-supplemented group. Similar data about significantly lower mineral content in animals after probiotic intake vs untreated animals were reported by Raghebian et al. (2007).

Conclusion

The results from the present study demonstrated the next.

The general health status of IlF lambs that received a dietary daily supplement of 8 g Immunobeta prebiotic and the combination of 4 g Zoovit probiotic + 8 g Immunobeta prebiotic was better, without signs of digestive disorders unlike the lambs from the control group.

The lambs supplemented either with the Immunobeta prebiotic or the Zoovit probiotic + Immunobeta prebiotic had a statistically significantly higher slaughter live weight than controls by 7.74% and 12.08%, respectively.

The daily weight gain of lambs supplemented with the Immunobeta prebiotic was increased by 21.74% vs controls, while the weight gain of lambs that received Zoovit + Immunobeta: by 17.39% than that of untreated lambs. Furthermore, the animals supplemented with either prebiotic and probiotic + prebiotic attained the slaughter live weight over a considerably shorter period of time.

The values of WHC of *m. LL* in IlF lambs from experimental group I and II demonstrated a statistically significantly higher average moisture loss (19.24% and 17.63%) than that of meat from control animals: 12.32%.

References

Abd El-Tawab, M. M., Youssef, I. M. I., Bakr, H. A., Fthenakis, G. C. & Giadinis, N. D. (2016). Role of probiotics in nutrition and health of small ruminants. *Polish Journal of Veterinary Sciences*, *19*(4), 893-906.

Adhikari, P. A. & Kim, W. K. (2017). Overview of prebiotics and probiotics: focus on performance, gut health and immunity. A review. *Ann. Anim. Sci.*, *17*(4), 949-966.

Al-Shawi, S. G., Dang, D. S., Yousif, A. Y., Al-Younis, Z. K., Najm, T. A. & Matarneh, S. K. (2020). The potential use of probiotics to improve animal health, efficiency, and meat quality: A Review. *Agriculture*, *2020*(10), 452.

Antunovic, Z., Marcela, S., Liker, B., Seric, V., Sencic, D., Domacinovic, M. & Speranda, T. (2005). Influence of feeding the Probiotic Pioneer PDFM® to growing lambs on performances and blood composition. *Acta Veterinaria (Beograd)*, *55*(4), 287-300.

Antunovic, Z., Šperanda, M., Amidžiü, D., Šeriü, V., Steiner, Z., Domaüinoviü, M. & Boli, F. (2006). Probiotic application in lambs nutrition. *Krmiva, 48*(4), 175-180 (EN).

BDS 15437:1982 – Meat and meat products. Method for determination of moisture content – https://bds-bg.org/bg/project/show/bds:proj:19683

BDS 9374:1982 – Meat and meat products. Determination of protein content – https://bds-bg.org/bg/project/show/bds:proj:27803.

BDS 8549:1992 – Meat and meat products. Determination of fats – https://bds-bg.org/bg/project/show/bds:proj:27130

Berge, A. C. B, Lindeque, P., Moore, D. A. & Sischo, W. M. (2005). A clinical trial evaluating prophylactic and therapeutic antibiotic use on health and performance of preweaned calves. *Journal of Dairy Science*, *88*(6), 2166-2177.

Chen, Y., Cheng, Y., Wen, C., Kang, Y., Wang, A. & Zhou, Y. (2018). Effects of dietary synbiotic supplementation as an alternative to antibiotic on the growth performance, carcass characteristics, meat quality, immunity, andoxidative status of Cherry Valley ducks. *J. Poult. Sci.*, *55*, 182-189.

Dibner, J. J. & Richards, J. D. (2005). Antibiotic growth promoters in agriculture: history and mode of action. *Poult. Sci.*, *84*, 634-643.

Dimova, N., Baltadjieva, M., Karabashev, V., Laleva, S., Popova, Y., Slavova, P., Krastanov, J. & Kalaydjiev, G. (2013). Effect of adding of probiotic „zoovit" at feeding of lambs from breed synthetic population bulgarian milk. *Bulg. J. Agric. Sci.*, *19*(1), 98-101.

Economou, V. & Gousia, P. (2015). Agriculture and food animals as a source of antimicrobial-resistant bacteria. *Infection and Drug Resistance*, *8*, 49-61.

Ezema, C. (2013). Probiotics in animal production: A review. *Journal of Veterinary Medicine and Animal Health*, *5*(11), 308-316.

Food and Agriculture Organization (FAO) (2002). Guidelines for the Evaluation of Probiotics in Food; Report of a Joint FAO/WHO Working Group on Drafting Guidelines for the Evaluation of Probiotics in Food; FAO: London, ON, Canada, 30 April–1 May.

Gibson, R. G. & Roberfroid, M. B. (1995). Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. *J. Nutr*., *125*, 1401- 1412.

Gomes, R. C., Leme, P. R., Silva, S. L., Antunes, M. T. & Guedes, C. F. (2009). Carcass quality of feedlot finished steers fed yeast, monensin, and the association of both additives. *Arq. Bras. Med. Vet. Zootec*., *61*(3),648-654.

Grau, R. & Hamm, R. (1953). A simple method for determination of water binding in muscles. *Naturwissenschaften*, *40*(1), 29-30.

Hamdon, H. A. & Farghaly, M. M. (2016). Improving growth performance and carcass characteristics of lambs as a result

caring management via dietary yeast supplementation. *Egyptian J. Anim. Prod*., *53*(2), 103-110.

Hill, C. Guarner, F., Reid, G., Gibson, G. R., Merenstein, D. J., Pot, B., Morelli, L., Canani, R. B., Flint, H. J., Salminen, S., Calder, P. C. & Sanders, M. E. (2014). Expert consensus document: The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. *Nat. Rev. Gastroenterol. Hepatol.*, *11*, 506-514.

Humayun Kober, A. K. M., Rajoka, M. S. R., Mehwish, H. M., Villena, J. & Kitazawa, H. (2022). Immunomodulation potential of probiotics: A novel strategy for improving livestock health, immunity, and productivity. *Microorganisms*, *10*, 388.

Hussein, A. F. (2014). Effect of biological additives on growth indices and physiological responses of Weaned Najdi Ram lambs. *Journal of Experimental Biology and Agricultural Sciences*, *2*(6), 597-607.

Hussein, A. F. (2018). Effect of probiotics on growth, some plasma biochemical parameters and immunoglobulins of growing Najdi lambs. *World Vet. J.*, *8*(4), 80-89.

Hussein, E. O. S., Ahmed, S. H., Abudabos, A. M., Suliman, G. M., Abd El-Hack, M. E., Swelum, A. A. & Alowaimer, A. N. (2020). Ameliorative effects of antibiotic-, probiotic- and phytobiotic-supplemented diets on the performance, intestinal health, carcass traits, and meat quality of clostridium perfringens-infected broilers. *Animals*, *10*, 669.

ISO 936 – Meat and meat products – Determination of total ash – http://www.iso.org/iso/catalogue_detail.htm?csnumber=24783.

Jukna, Č., Jukna, V. & Šimkus, A. (2005). The effect of probiotics and phytobiotics on meat properties and quality in pigs. *Veterinarija ir zootechnika*, *29*(51), 80-84 (EN).

Khare, A., Thorat, G., Bhimte, A. & Yadav, V. (2018). Mechanism of action of prebiotic and probiotic. *Journal of Entomology and Zoology Studies*, *6*(4), 51-53.

Kumar, S., Arnipalli, S. R. & Ziouzenkova, O. (2020). Review antibiotics in food chain: The consequences for antibiotic resistance. *Antibiotics*, *9*, 688.

Liu, C., Hou, Y., Su, R., Luo, Y., Dou, L., Yang, Z., Yao, D., Wang, B., Zhao, L., Su, L. & Jin, Y. (2022). Effect of dietary probiotics supplementation on meat quality, volatile flavor compounds, muscle fiber characteristics, and antioxidant capacity in lambs. *Food Sci. Nutr.*, *10*, 2646-2658.

Maiorano, G. & Bednarczyk, M. (2016). Prebiotics and synbiotics in broiler chicken production: *in vivo* performance and meat quality aspects: a review. *Slovak J. Anim. Sci.*, *49*(4), 151-156.

Milewski, S. & Zaleska, B. (2011). The effect of dietary supplementation with Saccharomyces cerevisiaen dried yeast on lambs meat quality. *Journal of Animal and Feed Sciences*, *20*, 537- 545.

Ordinance № 22 of 14 December 2005 on minimization of animal suffering during slaughter or killing – https://lex.bg/laws/ldoc/2135526211.

Ordinance № 26 of 28 February 2006 on conditions for the protection and welfare of animals during their transport – https://lex.bg/laws/ldoc/2135518328.

Ordinance No 40 of 2 December 2008 on the conditions for raising of agricultural animals, considering their physiological and behavioural characteristics – https://lex.bg/laws/ldoc/2135609448

Pandey, K. R., Naik, S. R. & Vakil, B. V. (2015). Probiotics, prebiotics and synbiotics- a review. *J. Food Sci. Technol.*, *52*(12), 7577-7587.

Parker, R. B. (1974). Probiotics, the other half of antibiotic story. *Animal Nutrition & Health*, *29*, 4-8.

Raghebian, M., Dabiri, N., Yazdi, A. B., Bahrani, M. J., Shomeyzi, J., Raghebian, A. & Hatami, P. (2007). Probiotic effect on meat quality and carcass parameters of Iranian Zandi lambs. *J. Livestock Sci*., *8*, 163-168.

Soumeh, E. A., Del Rocio Coba Cedeno, A., Niknafs, S., Bromfield, J. & Hoffman, L. C. (2021). The efficiency of probiotics administrated via different routes and doses in enhancing production performance, meat quality, gut morphology, and microbial profile of broiler chickens. *Animals*, *11*, 3607.

Titi, H. H., Dmour, R. O. & Abdullah, A. Y. (2008). Growth performance and carcass characteristics of Awassi lambs and Shami goat kids fed yeast culture in their finishing diet. *Animal Feed Science and Technology*, *142*(1–2), 33-43.

Urban-Chmiel, R., Marek, A., Stepien-Pysniak, D., Wieczorek, K., Dec, M., Nowaczek, A. & Osek, J. (2021). Review antibiotic resistance in bacteria. A Review. *Antibiotics*, *11*, 1079.

Uyeno, Y., Shigemori, S. & Shimosato, T. (2015). Minireview effect of probiotics/prebiotics on cattle health and productivity. *Microbes Environ.*, *30*(2), 126-132.

Vidovic, N. & Vidovic, S. (2020). Review antimicrobial resistance and food animals: Influence of livestock environment on the emergence and dissemination of antimicrobial resistance. *Antibiotics*, *9*, 52.

Zhou, Z., Xu, X., Luo, D., Zhou, Z., Zhang, S., He, R., An, T. & Sun, Q. (2023). Effect of dietary supplementation of Lactiplantibacillus plantarum N-1 and its synergies with Oligomeric Isomaltose on the growth performance and meat quality in Hu sheep. *Foods*, *12*, 1858.

Received: **November, 28, 2023**; *Approved*: **February, 02, 2024;** *Published:* **August, 2024**