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INFLUENCE OF *Saccharomyces cerevisiae* (Actisaf SC 47®) AS FEED ADITIVE IN GESTATION OR LACTATION DIETS ON SOWS AND NURSING PIGLETS HEALTH AND PERFORMANCE

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Abstract

The aim of this study was to investigate the effect of sows gestating or lactating diets supplemented with a commercial probiotic preparation (live yeast culture - *Saccharomyces cerevisiae*, "Actisaf Sc47®") on their health status, as well as the health status and productivity of their piglets during lactation. A total of 120 sows were divided into three groups: first (G, n=40) and second (L, n=40) group was fed diets with probiotic during pregnancy (G) or lactation (L), respectively. The third group (C, n = 40) was the control, which was fed without probiotic. Uterus and/or the udder diseases were manifested in the smaller ($p<0.01$) proportion in treated group (G=7.5%, L=12.5%) compared to control group (22.5%). The incidence of piglets diarrhea was lower ($p<0.05$) in the treated litters (12.5%) compared to the control litters (27.5 %). The average weaned piglets per litter (p/l) and weaning litter weight (lw) (G=11.6 p/l and 103.6 kg/lw; L=11.1 p/l and 102.8 kg/lw, C=10 p/l and 79 kg/lw) were higher ($p<0.01$ and $p<0.05$, respectively) in treated, compared to the control sows. These results show that the use of probiotic significantly improves the health status of lactating sows and piglets, as well as the piglets productivity within lactation.

Keywords: probiotics, diets, supplementation, performance, sows, piglets.

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UTICAJ DODAVANJA Saccharomyces cerevisiae (Actisaf SC 47®) U HRANU ZA KRMAČE TOKOM PERIODA GESTACIJE I LAKTACIJE NA ZDRAVLJE I PRODUKTIVNE PERFORMANSE PRASADI

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Kratak sadržaj

Cilj ovog rada je da se ispita uticaj dodatog komercijalnog probiotika (kulture živih kvasaca - *Saccharomyces cerevisiae*, "Actisaf Sc47™") u hranu za krmače u periodu gestacije i laktacije, na njihov zdravstveni status, kao i na zdravstveni status i produktivnost njihovih prasadi tokom perioda laktacije. Ukupno 120 krmača je podeljeno u tri grupe: prva (G, n=40) i druga (L, n=40) grupa koje su hranjene hranom sa dodatim probiotikom tokom gestacije (G) i laktacije (L). Treću grupu (n=40) su činile krmače hranjene hranom bez dodatka probiotika. Oboljenja uterusa i/ili vimena su manje ($p<0,01$) pokazivale tretirane grupe (G=7,5%, L=12,5%) u poređenju sa grupom kontrolnih krmača (22,5%). Incidenca pojave dijareja kod prasadi je niža ($p<0,05$) u tretiranoj grupi (12,5%) u odnosu na Prasad krmača iz kontrolne grupe (27,5 %). Prosečan broj odbijene prasadi po leglu (p/l) kao i težina legla kod odbijanja (tl) (G=11,6 p/l i 103,6 kg tl; L=11,1 p/l i 102,8 kg tl; C=10 p/l i 79 kg tl) su bili veći ($p<0,01$ i $p<0,05$, istim redom) u ogledним grupama u poređenju sa kontrolnom grupom krmača. Dobijeni rezultati pokazuju da se upotrebom probiotskih preparata značajno poboljšava zdravstveni status krmača u laktaciji i prasadi na sisi, kao i prasadi tokom perioda laktacije.

Ključne reči: probiotici, ishrana, performance, krmače, prasad

INTRODUCTION

Under the intensive production conditions, sows are exposed to numerous chronically stresogenic factors (Hyun et al., 1998; Sutherland et al., 2006), which reduce their immunity (Kick et al., 2012) and increase susceptibility to various infectious agents (Sutherland et al., 2006). In addition, the long-term application of conventional antimicrobial drugs for prevention or treatment of infectious diseases, result in significantly increase of infectious agent resistance to these antimicrobial preparations (Cromwell et al., 2002; Pugh, 2002; Le Coz, 2012). Reduced immunity and increased resistance of microorganisms to antimicrobial agents result in the increase of numerous infectious diseases, and consequently, reduce sows reproductive performances (Yeske, 2007; Stančić et al., 2010).

Nowadays, the problem of lower sow reproductive performance, as a result of reduced immunity and increased infective agents resistance to conventional antimicrobial preparation, is frequently attempt to solve by using probiotic preparations as natural immunomodulators (Blecha, 2001; Gallois et al., 2008; Zvekić et al., 2012; Apić and Zvekić, 2013). Live yeast culture (Gallois et al., 2009; Trckova et al., 2014) or their bioactive products (Kogan and Kocher, 2007; Shen et al., 2011) are one of the most active natural immunomodulator added to feed in order to prevent infectious diseases of the udder and the uterus, as well as to increase the reproductive performance of sows and their litters. However, according to previous studies, the effectiveness of replacing conventional antimicrobial agents with probiotics for the prevention and treatment of infectious diseases, as well as their impact on the sows reproductive performance, are not entirely consistent (Zvekić et al., 2012; Gallois et al., 2009; Trckova et al., 2014; Apić and Zvekić, 2013). The results of Serbian authors (Gagrčin et al., 2002; Stančić et al., 2012), demonstrated that in more than 50% of pig farms in R. of Serbia, there is a problem of udder and/or uterus infectious diseases (mastitis-metritis-agalactia syndrome; MMA - syndrome), resulting in significantly reduced sows reproductive performance.

Therefore, the aim of this study was to investigate the effect of adding one commercial probiotic preparation (live culture of *Saccharomyces cerevisiae*) in gestating or lactating diets on health status of sows and their litters, as well on productive performance of piglets within lactation.

MATERIALS AND METHODS

Farm and sows management

The experiment was carried out at one Serbian commercial pig farm, with about 1,200 Swedish Landrace and Large White sows in the reproductive herd. A total of 120 experimental sows (between the first and the sixth parity) were divided into three separate groups, immediately after artificial insemination. The first group (n=40 sows) was fed with probiotic supplemented diets during gestation (G group), the second group (n=40 sows) was fed with probiotic supplemented diets only within lactation period (L group), and the third control group (n=40 sows) was fed only with basic diets, without probiotics (C group). The sows in each experimental group were equalized according to body condition, parity and health. Average lactation period was 33 days. Duration of lactation period and parity was not significantly different ($p<0.05$) between the experimental group of sows (Table 1).

Table 1. Sows parity and duration of lactation ($\overline{X}$ ± SD)

Parameters	Sows feeding diets with the probiotic in:		Control group, without probiotic (C)
	Gestation (G)	Lactation (L)	
Number of sows	40	40	40
Parity (n)	$3,4^{a}$ ±1,48 (1-6)	$3,3^{a}$ ±1,39 (1-6)	$3,4^{a}$ ±1,38 (1-6)
Average lactation (days)	$33,0^{a}$±1,60 (30-35)	$33,3^{a}$±1,06 (31-35)	$33,2^{a}$±1,20 (31-35)

Minimal and maximal values are in parenthesis.

Values with different superscripts significantly differ: ^{ABC} ($p<0,01$); ^{abc}($p<0,05$).

The pregnant sows were housed in group pens (10 sows per group) and equalized by age, body condition and the stage of pregnancy. Between 7 and 10 days before the scheduled date of farrowing, the sows were moved into the farrowing house with individual pens, where they stayed with their litters during lactation.

Experimental sows diets

Standard feed for gestating and lactating sows were used as complete concentrate diet (produced by Veterinary Institute, "Subotica", Serbia). Composition of basic diets are given in Table 1. These diets were supplemented with 600g per ton of commercial probiotic preparation "Actisaf Sc47®", which contains live cells of *Saccharomyces cerevisiae strain CNCM I-4407* (Société Industrielle Lesaffre, Lesaffre Feed Additives, Marcq-en-Baroeul, France), to the basic feed for sows in gestation or lactation. During the first half of gestation, all sows received 3.2 kg of complete basic diet per day, and during the second half of gestation, 3.5 kg per day. Water was available ad libitum for pregnant and lactating sows.

Table 1. Composition of sows basic diets

Components	Gestating sows	Lactating sows
Crude protein (%)	13	16
Metabolic energy (MJ/kg)	11,5	11,8
Crude celulose (%)	9	7
Ca (%)	0,75-1	0,75-1
P (%)	0,55	0,55

Estrus detection, artificial insemination and pregnancy diagnosis

The estrus detection was performed twice daily by direct contact with the sexually mature teaser boar, starting on the first day after weaning. The semen was collected by hand-gloved method, from the boars of proven fertility, using phantom. The double artificial insemination (AI) was performed in the sows with estrus detected within first 7 days after weaning. The sows were first AI a few hours after standing estrus detection, and second time about 24 hours later. Freshly diluted insemination doses were used (dose volume of 100 mL, with about 4×10^9 progressively motile sperm). The insemination doses were kept in a thermo box at +17°C, and were used not more than 12 hours after collection.

The detection of possible return to estrus (i.e. first repeated estrus, rebreeding) start at day 14 after the first post-weaning AI. The diagnosis of pregnancy was recorded based on the absence of repeated estrus manifestation, as well as on the basis of a positive pregnancy testing results, using the "pulse- echo" ultrasound device. The ultrasound examination was performed 30 and 40 days after the last AI.

Lactating sows management

Gestating, lactating and the control sows and their litters were housed in a farrowing house with individual pens. First 3 days after farrowing, the sow rectal temperature was measured twice daily (according to the usual farm clinical practice, elevated rectal temperature was considered as ≥39.3°C). Water and adequate diets for each group of sows was available *ad libitum*. Group C was fed with basic diet, and group L and group G were fed with basic diet supplemented with "Actisaf Sc47®". Sows with clinically manifestation of uterine and/or udder disease, were treated by standard classical antimicrobial procedure.

In the case of occurrence of the uterine disease, the following signs were recorded: elevated rectal temperature, uterine discharge, no appetite. For udder disease (mastitis) recognizable clinical symptoms were: elevated rectal temperature, udder edema, hyperemia and pain, sternal position, hypo- or agalactia and no appetite.

Piglets were heated by floor heater and electric lamp (150W). Ten days after farrowing, until to weaning, piglets has received complete concentrated diets for nursing piglets (produced by Veterinary Institute "Subotica", R. of Serbia).

Data recorded

For sows the following data were recorded: sows rectal temperature within first 3 days after farrowing, clinically manifestation of uterine and/or mammary gland diseases after farrowing. Litter size and litter weight at farrowing, diarrhea, preweaning piglets mortality, litter size and litter weight at weaning were recorded.

Statistical analysis

The evaluation of phenotypic parameters of the research results was done by the "Statistic 12" software package according to the average, minimum and maximum values and standard deviation of the experimental results.

T-test was used to test the difference between the arithmetic means of the results and $p<0.05$ or lower was considered as a significant difference.

RESULTS

The experimental groups (G and L group) and control group (c group) were set up in such a way that between them there is no a statistically signifi-

cant difference ($p<0.05$) in the duration of lactation period and sows parity, as shown in Table 2.

Table 2. Sows parity and duration of lactation ($\bar{x}$ ± SD)

Parameters	Sows feeding diets with the probiotic in:		Control group, without probiotic (C)
	Gestation (G)	Lactation (L)	
Number of sows	40	40	40
Parity (n)	3.4^{a} ±1.48 (1-6)	3.3^{a} ±1.39 (1-6)	3.4^{a} ±1.38 (1-6)
Average lactation (days)	33.0^{a}±1.60 (30-35)	33.3^{a}±1.06 (31-35)	33.2^{a}±1.20 (31-35)

Minimal and maximal values are in parenthesis.
Values with different superscripts significantly differ: ^{ABC} ($p<0.01$); ^{abc}($p<0.05$).

In the first three days after farrowing a significantly higher proportion of control sows (22.5%) had elevated rectal temperatures (≥39.3°C) compared with those fed with diets supplemented with probiotic in gestation (7.5%) or lactation (12.5%). The results are given in Table 3.

Table 3. Sows health status within lactation ($\bar{x}$ ± SD)

Parameters Gestation (G)		Sows diets with the probiotic in:		Control group, without probiotic (C)
		Lactation (L)		
Number of sows		40	40	40
Sows with elevated rectal temperature[1]	n	3	5	9
	%	7.5^{A} ±1.68	12.5^{a} ±1.87	22.5^{Bb} ±2.43
Aver. elevated rectal temp. (°C)		39.6	39.9	39.8
Clinically manifestation of uterine and/or mammary gland diseases				
Metritis + hypogalactia	n	0	0	2
	%	0,0	0,0	5.0
Metritis + agalactia	n	0	1	0
	%	0.0	2.5	0,0
Mastitis + hypogalactia	n	3	2	2
	%	7.5	5.0	5.0

Parameters Gestation (G)		Sows diets with the probiotic in:		Control group, without probiotic (C)
		Lactation (L)		
Mastitis + agalactia	n	0	0	1
	%	0,0	0,0	2.5
MMA - syndrome	n	0	2	4
	%	0,0	5.0	10.0
Total sick sows	n	3	5	9
	%	7.5^{A} ±1.68	12.5^{a} ±1.87	22.5^{Bb} ±2.43

Minimal and maximal values in parenthesis; [1] Elevated rectal temperature: ≥39.3°C. Values with different superscripts significantly differ: ^{ABC} ($p<0.01$); ^{abc} ($p<0.05$).

In the sows with elevated rectal temperature, metritis with hypogalactia or agalactia, mastitis with hypogalactia or agalactia, or mastitis-metritis-agalactia syndrome (MMA) was noted mainly within the first week after farrowing (Table 3).

The average number of live born piglets per litter were 12.22 in the G-group, 11.53 in the L-group, and 11.42 piglets in the control group. These values were significantly ($p<0.05$) higher in the G-group in comparison with the control and L group of sows. However, average number of live born piglets per litter was not significantly different ($p>0.05$) between L and C group of sows (Table 4).

Table 4. Litter parameters from farrowing to weaning ($\overline{x}$ ± SD)

Parameters	Sows diets with the probiotic in:		Control group, without probiotic (C)
	Gestation (G)	Lactation (L)	
Number of litters	40	40	40
Total piglets born (n)	516	492	487
Total live born piglets (n)	489	461	457
Average stillborn piglets per litter (n)	0,67	0,77	0,75
Average live born piglets per litter (n)	12.22^{a} ±1.88 (8-16)	11.53^{b} ±2.17 (9-15)	11.42^{b} ±2.48 (7-16)
Average live born piglet weight (kg)	1.32 (1.0-1.72)	1.39 (1.0-1.65)	1.44 (1.2-1.80)

Parameters		Sows diets with the probiotic in:		Control group, without probiotic (C)
		Gestation (G)	Lactation (L)	
Average live born litter weight (kg)		16.07^{a} ±2.26 (12-21)	16.43^{a} ±2.17 (13-21)	16.47^{a} ±2.14 (7-21)
Litters with diarrhea	n	$5±0.33^{a}$	$5±0,33^{a}$	$11±0,45^{b}$
	%	12.5	12.5	27.5
Total piglets weaned (n)		466	446	400
Average weaned piglets per litter (n)		11.65^{A}±2.09 (7-16)	11.15^{a}±1.76 (7-14)	10.0^{Bb}±2.50 (4-16)
Total preweaning piglets mortality	n	23^{a}±2.32	15^{a}±2,26	57^{B}±2.92
	%	4.9	3,4	14.2
Average litter weight at weaning (kg)		103.6^{A}±15.66 (51-128)	102.8^{A}±13.53 (63-103)	79.1^{B}±16.9 (34-102)

Minimal and maximal values in parenthesis.
Values with different superscripts significantly differ: ^{ABC} ($p<0.01$); ^{abc} ($p<0.05$).

The average weight of a live born piglets per litter, in both treatment groups (G = 16.4 kg; L = 16.1 kg) was significantly higher ($p<0.01$) than in the control group (13.5 kg). Significantly higher average weaned piglets per litter were estimated in G-group (11.65 piglets, $p<0.01$), and in L-group sows (11.15 piglets, $p<0.05$) than in the control group of sows (10.0 piglets). Diarrhea in suckling piglets was manifested in 12.5% litters in both probiotic treated groups (G and L group), which is significantly lower ($p<0.05$) than in the untreated (control, C group) sows (27.5%). Preweaning piglet mortality was approximately 10% lower in the probiotic-treated sows (G = 4.9%; L = 3.4%) compared to the control sows (C = 14.2%). The average weaned litter weight was significantly higher ($p<0.01$) in both probiotic treated groups (G = 103.6 kg; L = 102.8 kg) in comparison with the control group of sows (79.1 kg) (Table 4).

DISCUSSION

Studies carried out on a large farm, representative for Serbian intensive pig production, shows that the average farrowing number per sow was 3.5 with the average 2.1 annual farrowing index. The average farrowing rate was 78.9%, and the average number of live born piglets per litter was 10.9. Total sows culling rate was 38.4% per year. About 42% of total culled sows were culled due to the health problems. According to Stančić et al. (2012) and Maletić et al. (2012) the diseases of the uterus and/or udder were primary reasons for culling 30,4% of the total sows culled due to the health problems in the Serbian pig farms. These authors also found permanent efficacy decreasment of conventional antimicrobial drugs used for treatment of uterus and/or udder diseases in sows, as well as for treatment of infectious diarrhea in newborn piglets, primarily due to increased resistance of the infectious agents to the number of antimicrobials. Similar problems related to increasing microbial resistance to conventional antimicrobial preparations have been shown by other authors (Wray and Gananou, 2000; McEwen and Fedorka-Cray, 2002). Therefore, the aim of this study was to solve this problem in lactating sows and their litters, by addition of commercial natural probiotic preparations in the diets of gestating or lactating sows, under Serbian intensive pig production conditions.

The results obtained in the present study indicate that feeding sows during pregnancy or lactation period by standard complete diets supplemented with probiotic *Saccharomyces cerevisiae CNCM I-4407 (Actisaf Sc47)* significantly improve their health status, (7.5% in G and 12.5% in L group of sows with clinical manifestation of uterine and/or mammary gland diseases, compared with 22.5% in the control group), as well as the health status of their piglets (12.5% litters with diarrhea in probiotic treated group in comparation with 27.5% litters with diarrhea in the control sows), and preweaning piglet mortality (4.9% in G-group, 3.4% in L-group and 14.2% in control group of sows). In addition, the average number of weaned piglets per litter (G = 11.65; L = 11.15) and the average litter weight at weaning (G = 103.6 kg; L= 102.8 kg) were significantly higher in the sows feed with probiotics in comparison with the control sows (79.1 kg).

Periparturient uterine and/or udder infectious diseases in the sows and coliform diarrhea in the newborn piglets are the main health factors that significantly reduce weaned piglets production (Yeske, 2007; Trckova et al., 2014; Shen et al., 2011; Böhmer et al., 2006; Kim et al., 2008).

In recent years, natural probiotics are used as substitutes for traditional antimicrobial preparations in animal production (Gallois et al., 2008; Giang,

2010; Bass, et al., 2012). Namely, it has been shown that microbial resistance to conventional antibiotics can be avoided by the application of probiotics (McEwen and Fedorka-Cray, 2002; Williams, 2010). Consequently, this prevents the appearance of residual antibiotics in the feed of animal origin used in human nutrition, and their harmful impact on the health of the human population (Wray and Gananou, 2000; Marshall and Stuart, 2011).

Although not clearly consistent, most researches show that the use of probiotic preparations (natural immunomodulators), containing live yeast, in the diets of pregnant and lactating sows, can significantly reduce puerperal uterus and/or mammary gland diseases (Giang at al., 2010; Kogan at al., 2007), newborn piglet infectious diarrhea (Gallois et al., 2009; Kim et al., 2008; Bass et al., 2012) and increase the preweaning piglet performance (Shen et al., 2011; Apić and Zvekić, 2013; Bass et al., 2012).

In the present study, the significant decrease of postpartal uterus and/or udder infectious diseases in the sows fed with diets supplemented with probiotics during gestation or lactation, may be the result of probiotics ability to enhance the sows natural immunity, as effect of Glucans + Mannan Oligosaccharide (Kogan and Kocher, 2007; Böhmer et al., 2006; Salmon, 2012). On the other hand, it has been shown that live yeast or their bioactive product mannan oligosaccharides can stimulate maternal immunoglobulin (Ig) production and their increasing presence in colostrum and milk (Gallois et al., 2009). Health protection of newborn piglets solely depends on these Ig (Zanello et al., 2012). Consequently, significant higher preweaning piglets mortality in the litters of postpartal sick sows, particulary in the control sows, obtained in the present study, can be primarily due to increasing incidence of diarrhea (Blecha, 2001), as a result of significant reduced or totally absent of milk production and/or Ig in colostrum and milk (Giang, 2010).

CONCLUSION

Live yeast probiotic supplementation in gestation diets significantly decrease the occurrence of postpartal uterine and/or udder diseases (7.5%) and increase the average number of live born piglets per liter (12.2), compared to sows fed diets supplemented with probiotic within lactation period (uterine and/or udder diseases 12.5%, and 11.5 live born piglets per litter), as well as with the control sows (uterine and/or udder diseases 22.5%, and 11.4 live born piglets per litter). Utilization of *Saccharomyces cerevisiae* live culture in the diets for pregnant or lactating sows, significantly improves their health status and the health status of their piglets within lactation in Serbian intensive

pig production conditions. In addition, litter productive parameters (average number of weaned piglets per litter and litter weight at weaning) were significantly higher in sows treated with probiotic than in untreated (control) sows.

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REFERENCES

1. Apić I., Zvekić D.: Litter parameters in primiparous sows treated with immunomodulators supplemnted in diets. In: Proceedings of the 23rd International symposium „New Technologies in Contemporary Animal Production", Book of Abstracts, June 19 – 21, 2013, Novi Sad, Serbia, organized by University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia.
2. Apić I., Zvekić D., Apić J., Savić B., Stančić I.: Litter parameters after newborn piglets peroral treatment with "Hokovit" immunomodulator preparations. *Kafkas Univ Vet Fak Derg* 6, 1007-1010, 2013.
3. Blecha F.: Immunomodulators for prevention and treatment of infectious diseases in food-producing animals. *Vet Clin North Am Food Anim Pract* 17, 3, 621-33, 2001
4. Bass B., Perez V., Yang H., Holzgraefe D., Chewning J., Maxwell C.: Impact of a whole yeast product on sow, litter and nursery performance. *Arkansas Animal Sciences Department Report 1*, 104-115, 2012.
5. Böhmer, M.B., Kramer M., Roth-Maier A.D.: Dietary probiotic supplementation and resulting effects on performance, health status, and microbial characteristics of primiparous sows. *J Anim Physiol Anim Nutr* 90, 309–315, 2006.
6. Cromwell, G.L.: Why and how antibiotics are used in swine production. *Anim Biotechnol* 13, 7–27, 2002.
7. Gagrčin M., Kovčin S., Stančić B.: Health and productive results on pig farms in AP Vojvodina (Serbia). *Cont Agri* 51, 265-268, 2002.
8. Gallois M., Oswald I.P.: Immunomodulators as efficient alternatives to in-feed antimicrobials in pig production? *Arch Zootech* 11, 3, 15-32, 2008.

9. Gallois M., Rothkötter H.J., Bailey M., Stokes C.R., Oswald I.P.: Natural alternatives to infeed antibiotics in pig production: can immunomodulators play a role? *Animal* 3, 1644-1661, 2009.
10. Giang, H.H.: Impact of bacteria and yeast with probiotic properties on performance, digestibility, health status and gut environment of growing pigs in Vietnam. PhD Thesis Swedish University of Agricult Sci Uppsala, 2010.
11. Hyun Y., Ellis M., Riskowski G., Johnson R.W.: Growth performance of pigs subjected to multiple concurrent environmental stressors. *Anim Sci* 76, 721–727, 1998.
12. Kick A.R., Tompkins M.B., Flowers W.L., Whisnant C.S., Almond G.W.: Effects of stress associated with weaning on the adaptive immune system in pigs. *Anim Sci* 90, 649-56, 2012
13. Kim S., Brandherm M., Freeland M., Newton B., Cook D., Yoon I.: Effect of yeast culture supplementation to gestation and lactation diet on growth of nursing piglets. *Asian-Aust J Anim Sci* 21, 1011-1014, 2008.
14. Kogan G., Kocher A.: Role of yeast cell wall polysaccharides in pig nutrition and health protection. *Livest Sci* 109, 161–165, 2007.
15. Le Coz P.: The effect of live yeast on colibacillosis in field conditions. www.allaboutfeed.net/Nutrition, AMCOVET, 2012.
16. Marshall M.B., Stuart B.L.: Food Animals and Antimicrobials: Impacts on Human Health. *Clin Microbiol Rev* 24, 718-733, 2011.
17. Maletić Z.: Reproductive efficiency of sows depending on the model of nutrition in pregnancy and lactation. PhD Thesis, University of Novi Sad, Serbia, Faculty of Agriculture, 2012
18. McEwen S.A., Fedorka-Cray P.J.: Antimicrobial use and resistance in animals. *Clin Infect Dis* 34, 93-106, 2002.
19. Pugh D.M.: The EU precautionary bans of animal feed additive antibiotics. *Toxicol Let* 128, 35–44, 2002.
20. Salmon H.: The effect of live yeast on sow-mediated immunity. http://en.engormix.com/MA-pig-industry , 2012.
21. Shen Y.B., Carroll J.A., Yoon I., Mateo R.D., Kim S.W.: Effects of supplementing Saccharomyces cerevisiae fermentation product in sow diets on performance of sows and nursing piglets. *Anim Sci* 89, 2462-2471, 2011.
22. Stančić B, Gagrčin M., Stančić Jelena, Stevančević O., Potkonjak A.: Infective and non-infective etiology of sow infertility. *Cont Agri*, 59, 180-193, 2010.
23. Stančić I., Radović I., Dragin S., Erdeljan M., Apić I.: Veterinary and zootechnical situation in artificial insemination at swine farm units in Vojvodina (Serbia). *Cont Agri* 61, 54-60, 2012.

24. Sutherland M.A., Niekamp S.R., Rodriguez-Zas S.L., Salak-Johnson J.L.: Impacts of chronic stress and social status on various physiological and performance measures in pigs of different breeds. *Anim Sci* 84, 588–596, 2006.
25. Trckova M., Faldyna M., Alexa P., Sramkova Zajacova Z., Gopfert E., Kumprechtova D., Auclair E., D'Inca R.: The effects of live yeast Saccharomyces cerevisiae on postweaning diarrhea, immune response, and growth performance in weaned piglets. *Anim Sci* 92, 767–774, 2014.
26. Wray C., Gnanou C.J.: Antibiotic resistance monitoring in bacteria of animal origin: analysis of national monitoring programmes. *Int J Antimicrob Agents* 14, 291–294, 2000.
27. Williams, N.T.: Probiotics. *Am J Health Syst Pharm* 67, 449-58, 2010.
28. Yeske, P.: Health problems that affect aertility. *Nat Hog Farmer* 15, 21-32, 2007.
29. Zanello G., Meuren F., Serreau D., Chevaleyre C., Melo S., Berri M., D'Inca R., Auclair E., Salmon H.: Effects of dietary yeast strains on immunoglobulin in colostrum and milk of sows. *Vet Immunol Immunopathol* 152, 1-2, 20-27, 2013.
30. Zvekić D., Apić I., Gagrčin M.: Dietary supplementation with natural immunomodulators and sows fertility. *Cont Agri* 61, 199-204, 2012.

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