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EFECTS OF ZINC-BACITRACIN (NUBATRIN®) AND SALINOMYCIN (GROSAL®) ON THE PERFORMANCE, CARCASS TRAITS AND MEAT CHARACTERISTICS OF FATTENING PIGS

UTJECAJ Zn-BACITRACINA (NUBATRIN®) I SALINOMICIN (GROSAL®) NA PERFORMANCU, OBILJEŽJA TRUPA I ZNAČAJKE MESA U TOVLJENIH SVINJA

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SUMMARY

In a fattening trial with one-hundred pigs allotted in individual boxes the effect of nutritive antibiotics zinc-bacitracin (as preparation Nubatrin®) or salinomycin (as preparation Grosal®) was studied. The experiment was divided into three periods: period 1 (27-50 kg l.w.), period 2 (50-75 kg l.w.) and period 3 (75-113 kg l.w.). Animals received feed finisher-1 in period 1 and feed finisher-2 in periods 2 and 3. They were divided into five groups. The feed (finisher-1/ -2) was either unsupplemented or supplemented with antibiotics as follows: CONT (0 ppm/ 0 ppm), NUBATRIN (50 ppm/ 20 ppm zinc-bacitracin), GROSAL-1 (30 ppm/ 15 ppm salinomycin), GROSAL-2 (40 ppm/ 25 ppm salinomycin), GROSAL-3 (60 ppm/ 30 ppm salinomycin). The results showed that the animals in NUBATRIN group gained significantly faster than CONT group especially in period 2 (7%, P<0,10) and period 3 (9%, P<0,05), they consumed more feed especially in period 3 (+9%, P<0,05), but had insignificant by better (2%) feed conversion results than CONT group. The most pronounced effect of salinomycin on growth parameters was found in GROSAL-2 group, where the animals gained 10% (P<0,05) faster in periods 2, 3, 2+3, by 9% (P<0,05) in the whole trial and they consumed more feed in periods 3, 2+3 and 1+2+3 (10%, 9% and 7% respectively), all the differences were significant. The results of GROSAL-1 and -3 were between CONT and GROSAL-2 groups. The differences in feed conversion among salinomycin supplemented groups and CONT were statistically insignificant, but a tendency of

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improvement in GROSAL-2 and -3 group was noted (in the whole experiment: 3%, not sig.). Comparing the results of zinc-bacitracin or salinomycin supplemented groups showed, that the improvement in GROSAL-2 was more pronounced. The carcass weights in all supplemented groups were higher (3-8%) than in the control group, but improvement in GROSAL-2 (+8%) proved to be statistically significant. The dressing percentage in groups NUBATRIN and GROSAL-2 improved significant by 0,4% and 0,5% respectively. The measurements of backfat and muscle depth showed no significant differences among groups, but in groups NUBATRIN and GROSAL-2 a tendency of thinner backfat (2-7% and 3-7% respectively) and greater muscle depth (4% and 3% respectively) could be seen, and as a consequence slightly improved meat percentage was found (+3% in both groups). To estimate meat quality pH and FOP were measured; according to the results neither pH nor FOP were effected by antibiotic supplementation.

INTRODUCTION

Antibiotics have been used as feed additives since 1950 (Braude et al, 1953). Through past decades the conditions for their application have changed and become more and more restrictive. Because of their considerable and reliable effect on daily gain, feed conversion and thereby productivity, antibiotics still take an important place among feed additives. Increased gain and improved feed conversion reduce waste production and thereby proportionally diminish environmental pollution which is nowadays an important aspect (Scheuermann, 1992; Buttery, 1993). Scheuer-mann (1992) explored the influence of salinomycin on retention and excretion of nitrogen in growing pigs. He proved that a smaller amount of protein was needed to achieve equal nitrogen retention in salinomycin supplemented feed; N excretion was reduced by 24%.

Many different factors can influence the degree of stimulative effect of nutritive antibiotics. The younger the pigs, the greater is the influence. Thaler and Wheaves (1993) have found greater improvement in growth and feed conversion in younger pigs than in older animals. In younger pigs growth increased by 15% but only 3,6% in older animals. Also improvement in feed conversion was bigger in younger (6,5%) than in older pigs (2,4%). Other factors that can influence the effect of nutritive antibiotics are: hygienic circumstances, general health condition and level of production; the better the results of production, the lower is the response to antibiotic supplementation (Kornegay et al., 1975).

The aim of our experiment was to study the effects of zinc-bacitracin (as preparation Nubatrin®) and salinomycin (as preparation Grosal®) supplementation on different growth parameters, carcass and meat quality in fattening pigs. Besides, we tried to verify the most efficient salinomycin dose. The experiment was conducted under very favourable conditions at a test station, where growth results were very high.

MATERIALS AND METHODS

One-hundred 83-87-day old crossbred pigs of both sexes (gilts and castrates) averaging 27 kg were randomly allotted to individual boxes at the commercial pig test station Emona-Ihan. The experiment lasted for 99 days and was divided into three periods: period 1 = 27-50 kg l.w. lasted for 29 days (until the age of 4 months); period 2 = 50-75 kg l.w. lasted for 29 days; period 3 = 75-113 kg l.w. lasted for 41 days (until the age of 6 months). All the animals had ad libitum access to feed and water. Feed was provided as pellets. In period 1 the animals received feed finisher-1 and in period 2 and 3 feed finisher-2 (table 1). They were divided into five groups. The feed (finisher-1/ -2) was either

unsupplemented or supplemented with zinc-bacitracin (as 20% preparation Nubatrin®, Krka, Novo Mesto, Slovenia) or salinomycin (as 12% preparation Grosal®, Krka, Novo Mesto, Slovenia) as follows: CONT (0 ppm/ 0 ppm), NUBATRIN (50 ppm/ 20 ppm zinc-bacitracin), GROSAL-1 (30 ppm/ 15 ppm salinomycin), GROSAL-2 (40 ppm/ 25 ppm salinomycin), GROSAL-3 (60 ppm/ 30 ppm salinomycin). Animal weight was recorded at the beginning of the experiment and at the end of each period. The individual feed consumption for each period was measured.

Table 1: The composition of the experimental diets

Tablica 1: Sastav pokusnih krmnih smjesa

		Finisher-1 Završna 1	Finisher-2 Završna 2
Barley - ječam	(%)	50.00	50.00
Wheat - pšenica	(%)	30.12	23.61
Maize - kukuruz	(%)	0.00	8.60
Sugar beet pulps with molasses Repini rezanci s melasom	(%)	0.00	6.00
Soybean meal - sojina sočiva	(%)	14.20	6.50
Fish meal - riblje brašno	(%)	1.00	1.00
NaCl	(%)	0.10	0.00
Limestone - vapnenac	(%)	0.75	0.68
Ca-Na-phosphate	(%)	1.65	1.34
L-lysine HCl	(%)	0.18	0.27
Vitamine and mineral premix	(%)	1.00	1.00
Binder - vezač	(%)	1.00	1.00
Dry matter - suha tvar	(g/kg)	876.8	883.4
Metabolisable energy*	(MJ ME/kg)	13.4	13.2
Crude protein - sir. bjelančevine	(g/kg)	158.3	131.6
Crude fat - sirova mast	(g/kg)	16.1	14.2
Crude fibre - sirova vlaknina	(g/kg)	39.6	51.6
Lys*	(g/kg)	8.9	7.8
Met+Cys*	(g/kg)	5.3	4.5
Ca	(g/kg)	9.1	8.6
P	(g/kg)	7.0	6.3
Na	(g/kg)	1.7	1.3

* calculated content - kalkulirani sadržaj

At the end of the experiment the animals were slaughtered. The following carcass measurements were taken from each pig: carcass weight, carcass length, fat depth on shoulder, middle of the back, at the beginning, middle and end of m. gluteus medius, muscle depth (from cranial edge of m.

gluteus medius to caudal edge of spinal canal). The carcass meat percentage was estimated by regression equation. Meat quality was estimated by measuring pH (pH_1 45 min. and pH_{24} 24 hours after slaughter) and colour (FOP: Fibre-Optic-Probe) 24 hours after slaughter in m. longissimus dorsi and m. semimembranosus.

Data were analysed using the General Linear Models (GLM) procedure from SAS® software (SAS Institute Inc., 1990) with the antibiotic concentration, sex and interaction among them as main effects. By analysing data obtained during fattening period the weight at the beginning of the experiment was taken in the model as covariable, but the final weight was used by analysis of data obtained at slaughter.

RESULTS AND DISCUSSION

The results of growth performance, presented in table 2,. show that supplementation with antibiotics caused important differences among groups. The animals in NUBATRIN group gained significantly faster than CONT group especially in period 3 (+9%, P<0,05), but also in other periods the gains in this group were somewhat better than in CONT group (period 2 + 3%, not sig.; period 2+3 + 7%, P<0,10; whole experiment +5%, not sig.). This is in agreement with other experimental results, for example with Hennig (1982), who found that zinc-bacitracin increased daily gain by 5% on average. The increase of daily gain was accompanied by increase of feed intake, which was mostly pronounced in period 3 (+9%, P<0,05). In period 1+2 as well as in the whole experiment the tendency of stimulated feed intake could be seen (+5% and +3%, not sig.). Because of accompanied increase in both daily gain and feed consumption, the improvement in feed conversion was not very pronounced (2%, not sig.), which is in agreement with average expected improvement (2,5%) summarised by Hennig (1982).

The supplementation with salinomycin proved to be even more efficient growth promoter than zinc-bacitracin. Especially pigs in GROSAL-2 group grew and gained in all experimental periods significantly faster than CONT group (period 1:3% and 7%, period 2: 5,5% and 10%, period 3:7% and 10%). Because of such pronounced improvement in daily gain in the whole experiment (+ 9%, P<0,05) the pigs of this group could achieve the same final weight as CONT group seven days earlier, which was similar to the results obtained by Böhme and Oslage (1986). The animals in GROSAL-1 and -3 groups also gained in all the periods somewhat faster (3-5%, not sig.) than CONT group. The increase in daily gain in GROSAL-2 group was accompanied by significant (P<0,05) increase in feed intake in period 3, 2+3 and in the whole experiment (+10, +9 and +7% respectively). In comparison with CONT group the feed intake somewhat increased in GROSAL-1 group (+4-6%, not sig.) too. The differences in feed conversion among salinomycin supplemented groups and CONT group were statistically insignificant, yet a tendency of improvement in GROSAL-2 and -3 group was noted (for whole experiment: 3%, not sig.). Comparison of the results with zinc-bactracin and salinomycin supplemented groups showed, that the increase in daily gain and feed intake was more pronounced in GROSAL-2 than in NUBATRIN group, but the difference was not statistically significant.

The results of growth and feed conversion obtained in this experiment are in agreement with the results of Petersen and Oslage (1980), where pigs feed with similar salinomycin concentrations (15, 20, 30 ppm in whole experiment) responded similarly: higher daily gains (5,0%, 5,4% and 3,4% respectively) and better feed conversion (3%, 4% and 3% respectively). But no effect of salinomycin on feed intake (0,1%, 0,9% and 1,2% respectively) was observed. In the trial by Lindemann et al. (1985), improved growth and better feed conversion in the fattening period (42-96 kg l.w.) by adding 27,5 ppm concentration of salinomycin was also found, but no influence on feed intake was evaluated.

Table 2: Growth performance in experimental periods (Ls-Means)

Tablica 2: Svojstva rasta u pokusnom razdoblju

		Cont Kontrola	Nubatrin	Grosal-1	Grosal-2	Grosal-3
Period 1 - Razdoblje 1						
Initial weight - Početna težina	(kg)	25.9	26.4	25.5	26.2	26.7
Final weight - Završna težina	(kg)	48.6^{a}	48.3^{ab}	48.6^{a}	50.2^{b}	50.2^{ab}
Daily gain - Dnevni prirast	(g/d)	755	742	752	808	811
Feed intake - Uzimanje hrane	(kg/d)	1.85	1.78	1.77	1.84	1.87
Feed conversion - Iskorištenje hrane	(kg/kg)	2.49	2.45	2.37	2.31	2.34
Period 2 - Razdoblje 2						
Final weight - Završna težina	(kg)	72.5^{a}	72.8^{ab}	74.5^{ab}	76.5^{b}	76.7^{ab}
Daily gain - Dnevni prirast	(g/d)	823^{ab}	847^{ab}	893^{ab}	909^{b}	913^{ab}
Feed intake - Uzimanje hrane	(kg/d)	2.74	2.72	2.77	2.90	2.88
Feed conversion - Iskorištenje hrane	(kg/kg)	3.40	3.26	3.14	3.26	3.16
Period 3 - Razdoblje 3						
Final weight - Završna težina	(kg)	109.2^{a}	112.9^{ab}	112.0^{a}	116.8^{b}	113.5^{a}
Daily gain - Dnevni prirast	(g/d)	894^{ab}	978^{b}	916^{ab}	983^{b}	897^{a}
Feed intake - Uzimanje hrane	(kg/d)	3.22^{a}	3.51^{b}	3.52^{ab}	3.55^{b}	3.32^{a}
Feed conversion - Iskorištenje hrane	(kg/kg)	3.63	3.61	3.88	3.63	3.74
Period 2+3 - Razdoblje 2+3						
Daily gain - Dnevni prirast	(g/d)	864^{a}	924^{ab}	907^{ab}	952^{b}	903^{a}
Feed intake - Uzimanje hrane	(kg/d)	3.02^{a}	3.18^{ab}	3.21^{ab}	3.28^{b}	3.14^{ab}
Feed conversion - Iskorištenje hrane	(kg/kg)	3.54	3.46	3.57	3.48	3.50
Period 1+2+3 (total trial) - Razdoblje 1+2+3 (ukupni pokus)						
Initial weight - Početna težina	(kg)	25.9	26.4	25.5	26.2	26.7
Final weight - Završna težina	(kg)	109.2^{a}	112.9^{ab}	112.0^{a}	116.8^{b}	113.5^{a}
Daily gain - Dnevni prirast	(g/d)	832^{a}	870^{ab}	861^{a}	910^{b}	876^{a}
Feed intake - Uzimanje hrane	(kg/d)	2.68^{a}	2.77^{ab}	2.79^{ab}	2.86^{b}	2.77^{ab}
Feed conversion - Iskorištenje hrane	(kg/kg)	3.25	3.20	3.25	3.17	3.17

Values possessing unlike subscript differ significantly (P<0,05)

Vrijednosti označene slovima značajno se razlikuju (P<0,05)

The results of Dzapo and Wassmuth (1981) showed, that fattening pigs (60-100 kg l.w.) which received 10 or 25 ppm salinomycin i feed consumed 1-3% more feed and gained faster by 5-4%., but the feed conversion was somewhat higher (2-3%) as in the unsupplemented group. The positive effects of salinomycin supplementation was more pronounced at higher levels (50 and 100 ppm). In the survey of Böhme and Oslage (1986) the positive effect of salinomycin was also estimated. In an experiment on fattening pigs similar salinomycin concentrations (50 ppm from 20 to 50 kg l.w. and 25 ppm from 50 to 105 kg l.w.) as in our trial were used. The increase in daily gain by 8%, improved feed conversion by 12%, but reduced feed intake by 8% was found. In their experiment salinomycin at higher concentrations proved to be less efficient; which is in agreement with our results.

As expected from the growth results, the carcass weights (table 3) in all supplemented groups were higher (3-8%) than in the control group, but only improvement in GROSAL-2 (+8%) proved to be statistically significant. Higher carcass weights after salinomycin administration were obtained also in experiment from Peterson and Oslage (1980). The dressing percentage in NUBATRIN and GROSAL-2 groups improved significantly by 0,4% and 0,5% respectively. The improvement is not large but it confirms improvement which was found also in other salinomycin studies (DeWilde, 1991). The measurements of backfat and muscle depth showed no differences among groups, which is in agreement with the results of other studies; for instance with the studies of Pacheco et al. (1988) and DeWilde (1991). Nevertheless, it has to be mentioned, that in NUBATRIN and GROSAL-2 group a tendency of thinner backfat (2-7% and 3-7% respectively) and greater muscle depth (4% and 3% respectively) could be seen, and as a consequence somewhat improved met percentage was found (+3% in both groups).

The pH and FOP values measured for the estimation of meat quality in m. longissimus dorsi and m. semimembranosus did not show any effect of antibiotic supplementation, which is in agreement with previously obtained results (Dzapo and Wassmuth, 1988).

CONCLUSIONS

The results proved, that althougt zinc-bacitracin and salinomycin were supplemented in very favourable feeding conditions, both turned out to be effective nutritional antibiotics. The increase in daily gain in NUBATRIN and especially in GROSAL-2 group was found. Because of extremely accelerated growth in GROSAL-2 group these animals could achieve same final weight as CONT group seven days earlier. Greater daily gains were connected with increased feed intake and in lesser (not sig.) extent with more efficient feed conversion. Carcass weight and dressing percentage in NUBATRIN and GROSAL-2 group were higher. The measurements of backfat and muscle depth showed no significant differences among groups, but in groups NUBATRIN and GROSAL-2 a tendency of thinner backfat and greater muscle depth could be seen, and as a consequence also somewhat improved meat percentage was found (+ 3% in both groups). To estimate meat quality pH and FOP were measured; according to the results neither pH nor FOP were effected by antibiotics supplementation. In these experimental conditions salinomycin in middle concentration was the most effective nutritive antibiotic.

Table 3: Carcass and meat characteristics of different groups (Ls-Means)
Tablica 3: Svojstva trupa i mesa različitih skupina

		Cont Kontrola	Nubatrin	Grosal-1	Grosal-2	Grosal-3
Carcass weight - Težina trupa	(kg)	87.5^{a}	91.2^{ab}	90.3^{a}	94.9^{b}	91.5^{a}
Dressing percentage - Randman	(%)	80.6^{a}	80.9^{bc}	80.8^{ab}	81.0^{c}	80.7^{ab}
Carcass length - Duljina trupa	(cm)	84.8	84.1	84.4	84.2	84.4
Backfat SH* - Leđna slanina SH	(mm)	42.7	42.2	43.3	40.5	41.0
Backfat MB* - Leđna slanina MB	(mm)	23.2	24.1	24.3	22.6	26.0
Backfat MG* - Leđna slanina MG	(mm)	24.0	22.4	24.6	22.4	23.8
Backfat BG* - Leđna slanina BG	(mm)	33.6	33.1	35.2	32.5	33.5
Backfat EG* - Leđna slanina EG	(mm)	27.5	26.9	28.1	26.3	28.3
Muscle depth - Dubina mišića	(mm)	68.2	71.0	71.1	70.1	71.2
Carcass meat - Mesnatost trupa	(%)	45.5	46.9	45.6	46.8	46.0
PH_1- m. longiss. dorsi		5.99	6.15	6.06	6.08	5.94
PH_1- m. semimembran.		6.20	6.15	6.23	6.19	6.13
PH_{24}- m. longiss. dorsi		5.95	5.91	5.97	5.88	5.85
PH_{24}- m. semimembran.		6.23	6.12	6.04	6.13	6.14
FOP-m. longiss. dorsi		44.4	38.2	41.3	42.3	48.6
FOP-m. semimembran.		26.9	27.4	28.8	28.0	27.8

Values possessing unlike superscript differ significantly (P<0,05)
Vrijednosti označene slovima značajno se razlikuju (P<0,05)
*SH = schoulder *MB = middle of the back, BG = beginning of m. gluteus medius, MG = middle of m. gluteus medius, EG = end of m. gluteus medius
SH = leđa, MB = sredina leđa, BG = početak m. gluteus medius, MG = sredina m. gluteus medius, EG = kraj m. gluteus medius

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SAŽETAK

U hranidbenom pokusu 100 tovnih svinja smještenih u individualne boksove istražen je utjecaj nutritivnih antibiotika Zn-bacitracina (u obliku proizvoda Nubatrin®) i salinomicina (u obliku proizvoda Grosal®). Pokus je bio podijeljen u tri razdoblja: 1. razdoblje (27 do 50 kg tjelesne mase), 2. razdoblje (50 do 75 kg t.m.) i 3. razdoblje (75 do 113 kg t.m.). U prvom razdoblju životinje su dobivale krmnu smjesu za predtov, u drugom i trećem krmnu smjesu za tov. Životinje su podijeljene u pet skupina, koje su u krmnim smjesama za predtov odnosno tov dobivale različite koncentracije nutritivnih antibiotika: KONT (0 ppm odnosno 0 ppm), NUBATRIN (50 ppm odn. 20 ppm Zn-bacitracina), GROSAL-1 (30 ppm odn. 15 ppm salinomicina), GROSAL-2 (40 ppm odn. 25 ppm salinomicina), GROSAL-3 (60 ppm odn. 30 ppm salinomicina). Rezultati pokazuju da su u skupini NUBATRIN prirasti bili veći u 3. (+9%, P<0,05) i u 2.+3. razdoblju (+7%, P<0,10), konzumacija krmne smjese prije svega u 3. razdoblju (+9%, P<0,05), dok razlike u iskorištavanju hrane nisu ustanovljene. Salinomicin je poboljšao tovne parametre najočitije u skupini GROSAL-2. Prirasti su u toj skupini u 2., 3. i 2.+3. razdoblju bili veći za 10% (P<0,05) i u prosjeku cijelog tova za 9% (P<0,05); konzumacija hrane je bila veća u 3., 2.+3. i 1.+2.+3. razdoblju za 10, 9 odn. 7% (sve razlike P<0,05). Pri spomenutim svojstvima leže rezultati skupina GROSAL-1 i -3 između skupina KONT i GROSAL-2. U konverziji nije došlo do signifikantnih razlika ali je ustanovljeno da su u skupinama tretiranim salinomycinom, kako u cijelom pokusu tako u pojedinačnim razdobljima pokusa, osim u zadnjem dijelu tova, bili nešto bolji (2-3%). Komparacija rezultata tova skupina hranjenih Zn-bacitracinom i salinomicinom pokazuje da je posebno skupina GROSAL-2 postigla nešto bolje rezultate od NUBATRIN skupine. Masa toplih klaoničkih polovica NUBATRIN skupine je bila veća za 4% (ne sig.) u skupinama GROSAL-1, -2 i -3 za 3% (ne sig.), 8% (P<0,05) odn. 5% (ne sig.). Randman u skupinama NUBATRIN i GROSAL-2 bio je također bolji za 0,3% (P<0,05) odn. za 0,4% (P<0,05). Niti Nubatrin a niti Grosal nisu signifikantno utjecali na debljinu leđne slanine. Zbog tendencije smanjenja debeljine leđne slanine (2-7% odn. 3-7%) i dubine mišića (4% odn. 3%) udio mesa u klaoničkim polovicama u skupinama NUBATRIN i GROSAL-2 bio je veći za 3% (ne sig.). Mjerenje pH i FOP u m. semimembranosus i m. longissimus dorsi ne upućuju na promjene u kakvoći mesa zbog dodatka tih nutritivnih antibiotika.