Journal of Animal and Veterinary Advances 4 (9): 785-788, 2005

Avoparcin Supplementation of Italian Friesian Dairy Cows Diet: Effects on Milk Quality

Paolo Polidori
Dipartimento di Scienze Veterinarie, Università degli Studi di Camerino,
Via Circonvallazione 93-62024 Matelica, Italy

Abstract: To evaluate the effects on milk quality of supplementary Avoparcin in the diet, 40 Italian Friesian dairy cows were divided into two homogeneous groups, the treated one fed with Avoparcin added to a mineral-vitaminic premix, the control one fed with the same premix without Avoparcin. The trial lasted 60 days after two adapting weeks; each cow of the treated group received 120 mg daily of Avoparcin during the treatment period. No differences were found beetwen the two groups of cows for the following parameters: milk yield, total protein, fat, somatic cells and total bacterial count, while in the milk of the treated group lactose content was significantly ($p<0.001$) higher. After 45 days of treatment, trans isomers fatty acid content significantly increased ($p<0.05$) in the milk of the treated group, and particularly trans-vaccenic acid. Also some unsaturated fatty acids (linoleic and linolenic acid) significantly increased ($p<0.05$) their concentrations in milk fat of cows fed with Avoparcin supplementation.

Key words: Avoparcin, fatty acids, milk quality, dairy cows

INTRODUCTION

Avoparcin is an antibiotic food additive originally isolated from a soil strain of Streptomyces candidus which has been extensively used in diets for pigs, broilers and beef cattle since 1976 to improve growth performance. The compound possesses a strong affinity for the cell walls of Gram-positive bacteria; many studies have noted reductions in feed intake and improvements in feed efficiency and daily gains with Avoparcin supplementation[1-3]. Past investigations have indicated that Avoparcin supplementation acts in the ruminant at least two sites: first, in the rumen, where its presence is reflected in enhanced production of propionate and in a decrease either of the molar proportions of acetate or in methane productions[4-6]; secondly in the small intestine, where its presence results in more efficient uptake of amino acid, as observed in past studies conducted either in pigs[7] or in sheep[8]. Many trials has been conducted to evaluate the effects of Avoparcin supplementation at different levels for improving the milk production in lactating dairy cows[9,10]. In this study the effects of Avoparcin supplementation on milk yield and especially on milk quality has been investigated; the following parameters were tested: total protein, fat, lactose, somatic cells and microbial content. It was analysed also fatty acid composition of milk fat and particularly cis and trans fatty acid isomers content, because fatty acid composition of milk affects both the texture and the flavor of dairy products and moreover, some unsaturated fatty acids, particularly cis and trans isomers, are very important for human nutrition, because they can cause physiological aberrations under dietary stress[11].

MATERIALS AND METHODS

The experiment took place in 1994, in a dairy farm located in the north of Italy. Forty multiparous lactating Italian Friesian cows averaging 22.6 kg milk per day were used. At 100±10 days post partum, cows were assigned to two experimental groups based on previous milk yield, lactation number and calving date. Each cow of the treated group received 120 mg/day of Avoparcin Avotan mineral feed, Cyanamid Italia SPA., 00040 Pomezia, while each cow of the other group received the same mineral-vitaminic premix without Avoparcin. The trial lasted 60 days after two adapting weeks, to adapt the rumen environment to the new plan of nutrition[12]. Cows were housed, independently of treatment group allocation, in a free-stall with freely available potable water and cubicle bedding with straw and were machine milked twice daily at 06.00 and 17.00 h. The cows were given a total mixed diet once daily at 10.00 h, control and treated cows always received the same diet (Table 1). During the treatment period, milk samples were taken at the beginning of the treatment and then every 15 days. Milk production was recorded daily for each cow, while two 24 h (am and pm) milk samples were collected from each cow every

Table 1: Chemical characteristics of feedstuffs

Sample	Luncerne hay	Ryegrass silage	Compound feed
Dry Matter †	88.1	92.0	90.3
Crude Protein ‡	8.0	13.5	1.8
Crude Fat ‡	2.0	1.5	5.4
Crude Fibre ‡	30.3	37.5	5.7
Ash ‡	5.9	11.7	8.8
NDF ‡	68.6	61.8	26.1
ADF ‡	37.4	44.0	9.7

†: g/100 g of feedstuff, ‡: % of dry matter

15 days during the treatment period to determine total protein, fat, lactose, somatic cells and total bacterial count, according to AOAC procedures[13].

Gas-chromatographic conditions: Neutral lipids were extracted from the milk[14], from total lipids were obtained fatty acids methyl esters[15] which were subjected to gas-chromatographic analysis using a Perkin Elmer (model 8700) gas chromatograph with a flame ionization detector and a split/splitless injector. Was used a fused-silica capillary column WCOT CP-Sil 88 (Chrompack) 50 m x 0.25 mm i.d., Helium as carrier gas and column temperature was held at 80°C for 4 min and then increased at a rate of 10°C min^{-1} from 80 to 160°C, at a rate of 3°C min^{-1} from 160 to a final temperature of 220°C (held for 3 min).

Statistical analysis: Results were subjected to the analysis of variance using general linear model procedure of the SA S package[16] and results were expressed as least square means. The statistical model for this analysis included group and treatment effects: appropriate interactions were also examined.

RESULTS

Milk yield and qualitative characteristics of milk: During the treatment period milk production of cows receiving 120 mg Avoparcin per head per day was decreased respect to the control group, while fat and total protein content was higher in the treated group but the effects of Avoparcin were not statistically significant (Table 2).

Table 2: Daily milk yield and qualitative characteristics of milk of the two groups of cows during the whole period (means±SE)

Sample	Avoparcin	Control
Milk Production†	19.50±1.0	21.40±1.1
Fat ‡	38.50±1.0	35.80±0.7
Total Protein ‡	30.40±0.4	29.90±0.4
Lactose ‡	49.90±0.4[a]	47.40±0.4[b]
Somatic Cells §	5.42±0.4	5.59±0.5
Total Bacterial Count §	4.88±0.4	4.94±0.4

†: kg/die, ‡: g/100 g of milk, §: Log mL^{-1}, Different superscript in the same row indicates significant difference, (b: ($p<0.001$)

Lactose content in the treated group was significant higher ($p<0.001$) than in the control group, according to a previous study[10], while somatic cells and microbial contents were lower in the cows fed with Avoparcin supplementation (Table 2), as demonstrated in other experiences[17,18].

Fatty acid composition of milk: Fatty acid composition of milk fat was altered by Avoparcin supplementation in the last period of the trial (Table 3 and 4), because concentrations of trans isomer fatty acids significantly increased ($p<0.05$) 30 and 45 days after the beginning of the treatment. Trans-vaccenic acid (trans-11-octadecenoic acid) was particularly higher in the treated group, either after 45 days ($p<0.001$) or 60 days ($p<0.05$) from the beginning of the trial. Linoleic acid ($C_{18:2}$) significantly increased($p<0.05$) after 30 days of trial, while linolenic acid ($C_{18:3}$) increased ($p<0.05$) after 15 days of trial (Table 5).

DISCUSSION

In this study, use of Avoparcin in diet of dairy cows did not improve milk yield in the treated group, in contrast with other experiences in the past[9,19].

Total protein and fat content were higher but not statistically significant in the milk of the cows fed with Avoparcin supplementation; lactose content was significantly higher ($p<0.001$) in the milk of the treated group, according to Abubakar *et al.*[10]. Confirming the results of previous studies, somatic cells and total bacterial count were lower in the treated group.

Table 3: Fatty acid composition of milk from control and treated groups (g/100 g total fatty acids)

	Short-chain fatty acid†		Long-chain fatty acid ‡		Saturated fatty acid		Unsaturated fatty acid	
	Mean±SE							
Samples	Control	Avoparcin	Control	Avoparcin	Control	Avoparcin	Control	Avoparcin
Before §	26.4±1.4	24.3±1.3	73.6±1.4	75.5±1.4	69.8±2.1	67.3±2.1	30.2±2.1	32.6±2.2
0 days ¶	27.0±1.4	25.9±1.4	72.9±1.4	74.0±1.4	69.4±2.1	68.8±2.1	30.5±2.1	31.1±2.1
15 days ¶	25.8±1.3	24.6±1.3	74.2±1.4	75.5±1.4	68.5±2.1	68.5±2.1	31.5±2.1	31.5±2.1
30 days ¶	23.1±1.3	23.7±1.3	77.6±1.4	76.2±1.4	67.2±2.1	70.7±2.1	33.6±2.1	29.2±2.1
45 days ¶	22.6±1.3	23.9±1.3	77.3±1.4	76.1±1.4	67.8±2.1	68.1±2.1	32.1±2.1	31.9±2.1

†: Short-chain fatty acids (C_4-C_{15}), ‡ Long-chain fatty acids (C_{16}-C_{20}), §: Sample taken before the commencement of Avoparcin supplementation
¶: Sample taken after the two adapting weeks and 15, 30, 45 and 60 days after the initial adapting period

Table 4: Concentrations of cis and trans fatty acid isomers of milk from control and treated group (g/100 g total fatty acid)

	Cis isomers †		Trans isomers ‡	
	Mean±SE			
Samples	Control	Avoparcin	Control	Avoparcin
Before §	24.9±2.0	27.2±2.1	2.1±1.6	2.2±1.6
0 days ¶	25.3±2.0	25.5±2.0	2.1±1.6	2.5±1.7
15 days ¶	26.1±2.0	25.8±2.0	2.3±1.6	2.6±1.7
30 days ¶	28.4±2.1	23.5±2.0	2.0±1.6[a]	2.5±1.7[b]
45 days ¶	26.8±2.0	25.8±2.0	2.4±1.6[a]	2.9±1.7[b]
60 days ¶	27.7±2.0	26.1±2.0	2.5±1.6	2.8±1.7

†: Cis isomers: $C_{16:1}$cis9, $C_{18:1}$cis9, ‡: Trans isomers: $C_{18:1}$trans9, $C_{18:1}$trans11, §: Sample taken before the commencement of Avoparcin supplementation, ¶: Sample taken after the two adapting weeks and 15, 30, 45 and 60 days after the initial adapting period; Different superscripts in the same row indicate significant difference, (b: ($p<0.05$)

Table 5: Concentrations of linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acids of milk from control and treated group (g/100 g total fatty acid)

	C18:2		C18:3	
	Mean±SE			
Sample	Control	Avoparcin	Control	Avoparcin
Before†	1.8±1.1	1.9±1.1	3.5±0.5	4.3±0.5
0 days‡	1.8±1.1	1.9±1.1	3.3±0.5	3.8±0.5
15 days‡	1.8±1.1	1.8±1.1	3.7±0.5[a]	5.3±0.5[b]
30 days‡	1.5±1.1[a]	1.9±1.4[b]	4.1±0.5	4.2±0.5
45 days‡	1.6±1.1	1.8±1.1	4.3±0.5	3.8±0.5

†: Sample taken before the commencement of Avoparcin supplementation, ‡: Sample taken after the two adapting weeks and 15, 30, 45 and 60 days after the initial adapting period, different superscripts in the same row indicate significant difference , (b: ($p<0.05$)

Milk fat from cows treated with Avoparcin was lower in unsaturated fatty acids compared with that from control cows, especially during the last period of the treatment; this can influence the flavor and physical properties of dairy products, because the ratio of saturated to unsaturated fatty acids can affect the melting and spreadability of butter, for example [20]. Concentrations of trans isomers fatty acids significantly increased ($p<0.05$) 30 and 45 days after the beginning of the treatment, and also concentration of two other unsaturated fatty acids increased in the last period of the trial: linolenic acid ($C_{18:3}$) and linoleic acid ($C_{18:2}$) significantly increased ($p<0.05$) respectively after 15 and after 30 days from the beginning of the treatment.

Consequently, nutritional characteristics of milk from cows fed with supplementary Avoparcin are slightly different respect to the control group, especially after 30 days of treatment: these results could suggest further investigations on the effects of Avoparcin on milk quality after a longer period of treatment, because it is important to understand if these alterations of fatty acid composition of milk caused by Avoparcin agree with the recommendations of many human health professionals.

The results obtained could not be completely explained, according to Abubakar *et al.*[19], by changes in the proportions of the major volatile fatty acids in the rumen: clearly, more research is needed to more fully detail the interesting actions of Avoparcin on the rumen ecology.

REFFERNCES

1. Johnson, R. J., M. L. Herlugson, L. Bola Ojikutu, G. Cordova, I. A. Dyer, P. Zimmer and R. DeLay, 1979. Effect of avoparcin and monensin on feed lot performence of beef cattle. J. Anim. Sci., 48: 1338-1342.
2. Trevis, J., 1979. Avoparcin promotes gains, efficiency in Texas trials. Feedstuffs, 42: 20.
3. Mudd, A.J., 1982. The use of Avoparcin as a growth promoter for beef cattle in Europe. Anim. Prod., 34: 376.
4. Dyer, I.A., R.M. Koes, M.L. Herlugson, L. Bola Ojikutu, R.L. Preston, P. Zimmer and R. DeLay, 1980. Effect of avoparcin and monensin on performance of finishing heifers. J. Anim. Sci., 51: 843-846.
5. Chalupa, W., C. Oppegard, H. C. Williams, B. Bloch and G. Perkins, 1981. Effect of avoparcin on rumen environment and fermentation. J. Anim. Sci., 53: 387.
6. Froetschell, M.A.,W.J.Jr. Croom, H.R. Gaskins, E.S. Leonard and M.D. Whitacre, 1983. Effects of avoparcin on ruminal propionate production and amino acid degradation in sheep fed high and low fiber diets. J. Nutr., 113: 1355-1362.
7. Ellis, M., M. Davies, P.A. Briggs and D.G. Armstrong, 1983. A note on the influence of Avoparcin on apparent digestibility and nitrogen retention in growing pigs. Anim. Prod., 36: 151-153.
8. MacGregor, R.C. and D.G. Armstrong, 1984. The feed antibiotic Avoparcin and net uptake of amino acids from the small intestine of sheep. Can. J. Anim. Sci., 64: 134-135.
9. Parker, L. D. and H. Smith, 1987. Evaluation of Avotan (Avoparcin) for improving milk production of dairy cows in Europe. Anim. Prod., 44: 461.
10. Abubakar, M.M., P. Rowlinson and D.G. Armstrong, 1988. The influence of the dietary inclusion of the antibiotic Avoparcin on the lactation performance of dairy cows. Anim. Prod., 46: 483.
11. Hunter, J.E. and T.H. Applewhite, 1986. Isomeric fatty acids in the US diet: Levels and health perspectives. Am. J. Clin. Nutr., 44: 707-717.
12. Broster, W.H. and V.J. Broster, 1984. Reviews of the progress of Dairy Science: Long term effects of plane of nutrition on the performance of the dairy cow. J. Dairy Res., 51: 149-196.

13. AOAC., 1990, Official Methods of Analysis. 15th Edn., AOAC, Arlington, VA.
14. Bligh, E.G. and W.J. Dyer, 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., 37: 911-917.
15. Sukhija, P.S. and D.L. Palmquist, 1988. Rapid method for determination of total fatty acid content and composition of feedstuffs and faeces. J. Agric. Food Chem., 36: 1202-1206.
16. SAS., 2001. User's guide. SAS Institute, Cary, NC.
17. Bosi, P., L. Casini, S. Dall'Olio, R. Davoli, D. P. Lo Fiego, P. Macchioni and V. Russo, 1991. Impiego dell'Avoparcina nella dieta di vacche adibite alla produzione di latte per il Parmigiano-Reggiano. Proceedings IX Congresso Nazionale ASPA, Roma, pp: 239-250.
18. Succi, G., G. Ruffo, G. M. Crovetto, F. Brunner, A. Sandrucci, 1991. Impiego dell'Avoparcina nell'alimentazione della bovina e caratteristiche quanti-qualitative del latte. Proceedings IX Congresso Nazionale ASPA, Roma, pp: 251-258.
19. Piva, G., A. Lazzari, and F. Masoero, 1988. Modulazione delle fermentazioni ruminalie produzione dilatte. Proceedings Società Italiana di Buiatria, Bologna, 20: 567-573.
20. Baer, R.J., 1991. Alteration of the fatty acid content of milk fat. J. Food Protect., 54: 383-386.