Partial substitution of maize with soya bean hulls in the concentrate for grazing dairy cows

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A typical concentrate for grazing dairy cows often consists of up to 70 to 80% maize grain. The price of maize grain varies depending on supply and demand. High maize prices make the use of less expensive sources such as by-products (Van Wyngaard et al., 2015) a viable option.

Previous research at the Outeniqua Research Farm found that partial replacement of maize grain with highly digestible by-products such as bran, hominy chop and gluten 20 increased milk-fat percentage while milk yield was not compromised.

Soya bean hulls is a high-fibre by-product of soya beans. The hull is separated from the bean during the extraction process and can represent 8% of the total weight of the bean (Barbosa *et al*., 2008). Soya bean hulls are digested more efficiently by ruminants than by monogastrics (Barbosa *et al*., 2008).

Concentrates with high levels of maize may compromise fibre digestion when fed at high levels to cows grazing high-quality grass. The aim of this study was to determine the effect of partial substitution of maize grain with soya bean hulls in concentrates for dairy cows, on milk production and milk composition.

Materials and methods

The study was carried out at Outeniqua Research Farm near George, Western Cape, South Africa. George has a temperate climate with a long-term (50 years) mean annual precipitation of 730mm. The study was carried out from 31 August 2017 to 2 November 2017 with a 14-day adaptation period and a 50-day measurement period.

The grazing camp of 8,6ha had permanent irrigation and kikuyu (*Pennisetum clandestinum*) as a base oversown with an annual Italian ryegrass, cultivar Yolande (*Lolium multiflorum*), at 24kg/ha during April 2017. After grazing, pastures were top-dressed with 100kg/ha limestone ammonium nitrate (LAN). The LAN contained 28% nitrogen (N), resulting in 28kg N/ha being applied after each grazing.

Pasture yield was estimated using a rising plate meter (RPM) and a

Table 1: Mean (± s.d.) DIM, lactation number and milk yield of cows allocated to the three concentrate treatments (n=17).

Parameter[1]	Treatments[2]					
	SH0		SH15		SH30	
DIM	125 ± 51		131 ± 54		124 ± 46	
Lactation no	3,59	± 1,37	4,59	± 1,24	3,76	± 1,77
Milk yield (kg)	19,7	± 2,00	19,8	± 2,61	19,8	± 2,11

[1]DIM = days in milk. [2]Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

seasonal regression equation: Y = 103 X H – 261 (Y = available dry matter (DM) herbage (kg/ha) and H = RPM height reading). Cows grazed a new pasture strip after each milking and pasture was allocated at 10kg DM/cow/day.

A total of 51 multiparous Jersey cows were blocked according to milk yield three weeks prior to the study, DIM and lactation number (*Table 1*). Cows within a block were randomly allocated to one of the three concentrate treatments (*Table 2*) using a complete randomised block design.

Cows were separated into their treatment groups before milking and received 6kg/day of their allocated treatment concentrate in the milking parlour (3kg/milking). After milking, all cows grazed together as one group by means of strip grazing.

Milk yield was recorded daily and composite milk samples per cow were collected four times during the data collection period. Pasture and concentrate samples were collected weekly and pooled over two weeks for analyses at a later stage. A pasture regression was also cut weekly. Live weight (LW) and body condition score (BCS) were determined at the start and end of the study.

Results and discussion

The chemical composition of concentrates and pasture is reflected in *Table 3*. As the level of soya bean hulls increased in the concentrate, the NDF and acid detergent

Table 2: Ingredient composition of the three concentrates used in the study.

Ingredients (% of DM)[1]	Treatments[2]		
	SH0	SH15	SH30
Maize meal	80	65	50
Soya bean hull	0	15	30
Wheat bran	5,45	5,92	6,4
Molasses	6	6	6
Soya bean oilcake	5	5	5
Mono-calcium phosphate	0,4	0,5	0,6
Feed lime	1,8	1,5	1,2
Salt	0,5	0,5	0,5
Magnesium oxide	0,3	0,25	0,2
Urea	0,45	0,23	0
Premix	0,1	0,1	0,1
ME (MJ/kg)	12	12,7	12,5
Crude protein	12,2	12,2	12,3
Ether extract	3,21	3	2,79
NDF	11,1	19,8	28,5
ADF	4,45	10,59	16,74
Starch	62	51,4	40,8
Calcium	0,85	0,86	0,87
Phosphorous	0,45	0,45	0,45
Magnesium	0,36	0,36	0,35

[1]ME = Metabolisable energy; NDF = Neutral detergent fibre; ADF = Acid detergent fibre. [2]Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

Table 3: Mean (± s.d.) chemical composition of the three concentrate supplements used in the study and pasture samples collected over a seven-week period on a dry matter basis.

Parameter[1] (% of DM)	Treatments[2]			Pasture
	SH0	SH15	SH30	
DM	92,1	91,8	91,7	16,4
Ash	5,02	5,18	5,68	10,3
CP	10,9	10,9	11,3	19,4
NDF	8,05	16,3	24,6	43,7
NDIN	0,572	0,929	1,15	1,93
ADF	3,1	10,3	17,2	27,6
ADIN	1,3	0,635	0,439	0,98
ADL	0,515	0,711	1,09	5,39
Ca	0,826	0,769	0,885	0,455
P	0,386	0,392	0,408	0,406
Mg	0,352	0,353	0,364	0,399
K	0,808	1	1,15	2,24

[1]DM = Dry matter; CP = Crude protein; NDF = Neutral detergent fibre; NDIN = Neutral detergent insoluble nitrogen; ADF = Acid detergent fibre; ADIN = Acid detergent insoluble nitrogen; Ca = Calcium; P = Phosphorous; Mg = Magnesium; K = Potassium. [2]Concentrates SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

Table 4: Mean milk yield, milk composition (fat, protein, lactose, SCC and MUN), live weight and body condition score of cows receiving a different concentrate supplement (n = 17).

Parameter[1]	Treatments[2]			SEM[3]	Contrasts[4]		
	SH0	SH15	SH30		1 vs 2	1 vs 3	2 vs 3
Milk yield (kg/cow/day)	19,3	19,4	19,2	0,44	0,98	0,79	0,78
4% FCM (kg/cow/day)	22,4	23,5	23	0,61	0,23	0,51	0,58
ECM (kg/cow/day)	23,9	25	24,5	0,6	0,21	0,45	0,61
Fat (%)	5,12	5,48	5,33	0,127	0,06	0,26	0,41
Protein (%)	3,67	3,81	3,82	0,046	0,04	0,03	0,82
Lactose (%)	4,55	4,74	4,75	0,036	0	0	0,79
SCC (x 1000/mL)	164	205	201	47,6	0,55	0,58	0,96
MUN (mg/dL)	8,3	8,54	9,36	0,256	0,5	0,01	0,03
LW before (kg)	386	389	389	10,1	0,86	0,88	0,98
LW after (kg)	422	426	419	10,5	0,75	0,84	0,6
LW change (kg)	+35,4	+37,6	+30,1	2,64	0,56	0,17	0,06
ADG (kg/day)	0,55	0,59	0,47	0,041	0,56	0,17	0,06
BCS before	2,15	2,09	2,18	0,037	0,28	0,58	0,11
BCS after	2,24	2,31	2,26	0,039	0,19	0,6	0,43
BCS change	+0,09	+0,22	+0,09	0,038	0,02	1	0,02

[1]FCM = Fat corrected milk; ECM = Energy corrected milk; SCC = Somatic cell count; MUN = Milk urea nitrogen; LW = Live weight; ADG = Average daily gain; BCS = Body condition score. [2]Concentrate SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls (SH), respectively. [3]SEM = Standard error of the mean. [4]p≤0,05 = significant difference; p>0,05-0,10 = significant trend.

Table 5: Milk price, income and monthly increase in profit if 0, 15 or 30% of maize is replaced with soya bean hulls in concentrates for 400 Jersey cows grazing ryegrass during spring.

	SH0	SH15	SH30
Milk price R/kg	R5,21	R5,41	R5,39
Milk production kg/cow/day	19,3	19,4	19,2
Milk income R/month	R1 206 636	R1 259 448	R1 241 856
Milk profit/month increase	-	R52 812	R35 220

Concentrate SH0, SH15 and SH30 containing 0%, 15% and 30% soya bean hulls, respectively.

fibre (ADF) increased substantially (*Table 3*). The crude protein (CP) was similar for the different concentrates. The pasture was of high quality as indicated by the CP and NDF content.

Production data is presented in *Table 4*. Milk yield, 4% fat corrected milk (FCM) and energy corrected milk (ECM) was not affected by the inclusion of soya bean hulls in the concentrates. There was a tendency (P=0,06) for the milk fat percentage to be higher on the SH15 treatment compared to the SH0 control.

The replacement of maize with soya bean hulls resulted in significant increases (p<0,05) in milk protein and lactose content. The milk urea nitrogen (MUN) content indicates that protein in the total diet was sufficient for all the treatments.

Cows on all three treatments gained in body weight, but no significant (p>0,05) differences were found between treatments. Body condition score of cows on all three treatments did increase with a significant difference (p<0,05) between the 15% soya bean hull concentrate treatment and the other two treatments.

Economic implications

Milk composition and production data was given to our milk buyer to determine milk prices for three concentrate treatments. If a dairy farmer is milking 400 cows, supplement concentrate at 6kg/cow/day and the cost of soya bean hulls is the same as that of maize grain, the income benefit is shown in *Table 5*.

Conclusion

Soya bean hulls have great potential as feed source to partially replace maize grain in concentrates for grazing dairy cows in spring. Milk production was not compromised while milk protein and milk lactose content increased. Higher milk prices can be expected due to the positive effect of soya bean hulls on milk solids.

For more information and references, contact Prof Robin Meeske at RobinM@elsenburg.com.