The use of oilseed cake (ram press sunflower cake) from small-scale processing operations for inclusion in rations for peri-urban goat production in Zimbabwe

Abstract

The use of ram-pressed sunflower cake (SFC) as a supplement to kapeters (male castrate goats) subsisting on low quality basal diet was evaluated in a growth study. Twenty-four kapeters (14.62±3.321 kg) were divided into four treatment groups based on weight in a randomised complete block design study. These four groups received the same basal diet (60 % maize stover: 30 % groundnut tops: 10 % sunflower heads). According to treatment they were then offered 0 (control), 15, 30 and 45 $g/kg^{0.75}/d$ SFC as supplement. Daily feed intake and weekly weight changes were monitored for 56 days. There were no differences ($P>0.05$) in basal diet intake and total feed intake. On average the animals consumed 343.07 g d^{-1} of the basal diet (46.23 $g/kg^{0.75}/d$) and 413.92 g d^{-1} total feed intake. There was a tendency of a depression in basal diet intake with increased SFC supplementation. In terms of the growth rate, there were also no significant ($P>0.05$) differences across treatments. On all treatments, the animals lost weight, on average –0.0114 kg d^{-1}. The tendency was to having more severe weight losses on SFC supplemented diets. However, from the pattern of body weight changes, the diets could be ranked as control > 45 $g/kg^{0.75}/d$ > 30 $g/kg^{0.75}/d$ > 15 $g/kg^{0.75}/d$ supplementation levels. These results are indicative of the adverse effects of inclusion of supplementation with feeds having a fat content beyond 5 per cent. Efficiencies of sunflower seed removal from the heads and oil extraction from the ram press machines need to be improved if the cake is going to be used in ruminant livestock production.

Key words: Sunflower cake, sunflower head, groundnut tops, maize stover, goats

1. Introduction

Expansion of Peri-urban goat production in Zimbabwe is being hampered by a shortage of readily available feed resource both in quantity and quality, particularly in the dry season. In tropical and sub-tropical regions, the feed available for ruminants in the dry season is deficient in nitrogen, digestible energy and elements such as phosphorus, sodium, calcium, zinc, iodine and cobalt (Minson, 1982). These dietary deficiencies need to be corrected to enhance animal production.

Production of oilseeds, particularly sunflower in Zimbabwe's smallholder sector is significant and rural oil processing is being promoted. In 1996, an estimated 5 300 ram presses were in use throughout Africa. The breakdown included 1500 in Tanzania, 700 in Zimbabwe, 400 in Zambia, 250 in Kenya and approximately 1 000 in Uganda (Nayudamma, 1998). Appropriate Technology International, the leading agency in ram press development and dissemination has been promoting use of these machines in rural oil processing in Africa with the objectives of improving the nutritional status of the people. The by-product, sunflower cake (SFC) is potentially a good animal feed. It has both good protein content and energy in the form of fat (Mupeta, Weisberg, Hvelplund and Madsen, 1997).

The feeding of fats has been reviewed by Palmquist and Jenkins (1980), Storry (1981), Palmquist (1984). Incorporating additional fat in the diet offers several opportunities for improving the efficiency of energy utilization. Firstly the high energy density of fat may allow increased energy consumption and performance where energy intake is limiting. Secondly, increased fat availability from the diet may increase net efficiency of product synthesis. Thirdly, direct transfer of dietary fat to tissue would result in a partial efficiency of product synthesis. The fourth opportunity lies in the potential of substituting fat for rapidly fermentable carbohydrate in the diet fed to highly productive ruminant animals, thereby increasing forage fibre in relation to total dietary carbohydrate, improving rumen fermentation and fibre digestion and consequently tissue fat synthesis. In growing ruminant animals, the fifth advantage is the fact that fat may decrease the requirement for glucose and spare amino acids from breakdown for gluconeogenesis.

This study was conducted to evaluate the growth performance of growing kapeters offered a basal diet of maize stover mixed with sunflower heads and groundnut tops, and supplemented with SFC.

2. Materials and Methods

2.1. Site

The study was conducted at Henderson Research Station, Mazowe, Zimbabwe. The station is situated at 17°35′ South and 30°58′ East. The altitude is 1 290 m above sea level at the floor of the valley rising to 1 540 m on the hills. Henderson has a subtropical summer rainfall climate with the main rains starting in mid- to late-November and ending late in March or early April. The 45-year mean annual rainfall is 875.2 mm. The mean maximum temperature is 26.3°C and the mean minimum temperature is 10.4°C.

2.2. Animals and Housing

Twenty-four small east African male castrate goats (kapeters) (14.62 ± 3.321 kg) from the station flock were used. All kapeters were dosed with Tramisan (levamisole hydrochloride 2.5 % m/v and oxyclozanide 3.4 % m/v) and vaccinated with Heptavac (activates immunity against diseases caused by Clostridium species) as a prophylactic measure just before the start of the experiment.

The kapeters were confined in individual pens measuring 1.8 x 1.2 m and with sides of 1.3 m height stretching the length of the pen on both sides. Feed and water troughs were on the front end of the pen and a wire mesh enclosed the back end. No bedding was provided. Accumulated manure was removed once a week.

2.3 Diets

A basal diet consisting of 60 per cent maize stover, 30 per cent groundnut tops and 10 per cent sunflower heads was formulated. A vitamin mineral premix was included in the basal diet at 0.1 per cent. All stover ingredients were milled through a 25 mm screen sieve. Ram pressed Sunflower cake was offered as the supplement at four different levels: 0, 15, 30 and 45 $g/kg^{0.75}/d$. The chemical compositions of the ingredients are shown in Table 1.

2.4. Experimental Procedure

2.4.1. Experimental Design

The kapeters were ranked according to live weight. They were divided into four groups allowing for bodyweight, giving six animals per treatment. These groups were randomly allocated to the four different treatments. The design was a randomized complete block with weight being used as the blocking factor.

2.4.2. Feeding and Management

The animals were offered the basal diet and the supplements separately. The weights were measured on air-dry basis. Sunflower cake was offered at 0, 15, 30 and 45 $g/kg^{0.75}/d$ with the amounts calculated weekly after weighing. The basal diet was offered at 1.5 times the previous day's intake. Feed refusals were weighed daily. Live weight was measured every week throughout the experiment. Starved live weight was measured at the beginning and end o the experiment. Starving was effected by depriving the animals of feed for 24 hours and water for 12 hours. Starved weights were the basis for calculating live weight change. The experiment was conducted for 56 days.

2.5. Chemical analysis

Analyses of dry matter, ash nitrogen and ether extract were carried out according to AOAC (1984) procedures. Neutral detergent fibre was determined according to Van Soest, Robertson and Lewis (1991).

2.6. Statistical Analysis

Body weight data were analysed as a randomized complete block with initial body weight as a covariate according to the model:

$Y_{ijk} = \mu + B_i + T_j +$ ❁$*T_{ijk} + e_{ijk}$

while the rest of the data were analysed as a randomised complete block design using the model:

$Y_{ijk} = \mu + B_i + T_j + e_{ijk}$

In both models Y_{ijk} is the response of lamb k in block i and treatment j; μ = general mean; B_i = fixed effect of block; T_j = fixed effect of treatment; ❁ = regression coefficient of the covariate; T_{ijk}= the pretreatment average value (covariate) and e_{ijk} = the residual variation. Least squares means were computed and the differences between means were assessed using the PDIFF option in GLM procedures (SAS, 1996).

3. Results

3.1. Animal Health

Three animals died and one was removed from the experiment due to a fracture it sustained. These were one each from treatments one and three, while two were from treatment four.

3.2. Feed Intake

Intake data are presented on dry matter basis in Table 2. There were no significant (P>0.05) treatment differences on feed intake. There was however a tendency to depress basal diet intake with supplementation. The animals averaged 343.07 g d^{-1} basal diet intake. On metabolic weight basis the basal diet intake was 46.23 g/$kg^{0.75}$/d. There was a tendency to substitute for maize stover with supplementation. All indices for basal diet intake were less than 1. The animals on 30 and 45 g/$kg^{0.75}$/d SFC selected against SFC and were not consuming all that was offered. Total feed intake was consequently not significantly (P>0.05) different as well across diets. Total feed intake averaged 413.92 g d^{-1}. At 45 g/$kg^{0.75}$/d SFC supplementation, the animals ate very little of the cake compared to that at 30 g/$kg^{0.75}$/d.

3.3. Growth rate

Data on initial weight, final weight and weight change are shown in Table 3. There were no significant (P>0.05) treatment differences in these parameters. All animals in the four treatments lost weight. The average weight loss across treatments was –0.014 kg d^{-1}. With supplementation, body weight losses tended to be more severe.

The pattern of change in weight is shown in Figure 1. While the control dietary treatment maintained consistently higher weight throughout, the supplemented regimes maintained their weights at a lower level. The supplements in terms of mitigating severity of weight losses could be ranked as 45 g/$kg^{0.75}$ > 30 g/$kg^{0.75}$ > 15 g/$kg^{0.75}$.

4. Discussion

Dry season herbage from tropical and subtropical natural pasture is low in nitrogen and high in fibre (Minson, 1982) as was the case of the basal diet in this study. Both these factors contribute to the slow rate and low extent of digestion, resulting in low intake due to gut fill leading to poor animal production due to low nutrient supply. In this study maize stover was mixed with sunflower heads and groundnut tops to boost the nitrogen and energy of maize stover so that the animals receiving this treatment could survive.

Nitrogen and energy supplements increase the nutrient supply to the animal by altering digestion kinetics and intake (Faichney, 1996). However in this study there were no significant ($P>0.05$) differences in intake and growth performance amongst the different treatment groups.

It was anticipated that SFC would provide nitrogen and energy to enhance microbial proliferation in the rumen leading to greater dietary fermentation and also supply unfermentable digestible nitrogen to post-ruminal sites. The fat in SFC would have increased the energy density with the long chain fatty acids being metabolized more efficiently and the nitrogen providing a source of nitrogen for microbial growth and also some unfermentable digestible protein. Mupeta *et al.* (1997) using the mobile nylon bag technique, showed SFC to have the highest amino acid digestibility of individual amino acids, total amino acids and nitrogen compared to cottonseed meal, milkflow, groundnut tops and cowpea hay. However, in the current study, inclusion of SFC actually depressed total dietary intake and at 45 $g/kg^{0.75}/d$ supplementation, the animals actually selected against SFC.

Only three to five per cent unprotected fat appears to be tolerated by rumen microorganisms (Devendra and Lewis, 1974; Palmquist and Jenkins, 1980; Chalupa, Rickabaugh, Kronfeld and Sklan, 1984). The SFC used in this study had 34.2 per cent ether extract content while the basal diet had 5.1 per cent ether extract.

When extracted oils are fed to ruminants, they rapidly undergo lipolysis in the rumen and since they will be mainly in the form of triacylglycerols, they yield glycerol and free fatty acids. Glycerol is quickly fermented mainly to propionic acid. Free fatty acids can then either be incorporated into microbial lipid, for calcium or magnesium soaps (Jenkins and Palmquist, 1982), biohydrogenated if they are unsaturated or modified by the formation of geometrical (*trans*) from positional (*cis*) isomers or simply become adsorbed onto the solid surface of the digesta (Harfoot, Noble and Moore, 1973).

These processes of fat digestion have a great bearing upon rumen fermentation. Reports have been made of changes in microbial populations (White, Grainger, Baker and Stroud, 1958), ammonia, methane (Czerkawski, Blaxter and Wainman, 1966) and volatile fatty acid production (Ikwuegbu and Sutton, 1982) and of reduced cellulose and fibre digestion (Kowalczyk, Orskov, Robinson and Stewart, 1977) if levels greater than five per cent are included in the diet. However, the severity of such effects are modified by many dietary factors.

Several hypotheses have been advanced as explanation for these observed effects of fats. Physical coating of fibre with fat preventing microbial attack and or inhibition of microbial activity from surface active effects of fatty acids on cell membranes (Jenkins and Palmquist, 1982) are the more likely explanations.

This is probably what was occurring in this study. The very high ether extract content in SFC and the inherent high level of ether extract in the basal diet, probably caused by whole seed not totally removed from the sunflower heads, could have adversely affected SFC utilisation, in terms of the protein and energy, leading to poor performance of kapeters on SFC supplemented regimes.

It is concluded that the efficiency of oil extraction using ram press machines and removal of seed from the sunflower heads needs to be improved if the cake is going to be used in ruminant animal production. This would also enhance profitability of oil production and greater use of protein in SFC. Also incorporation of SFC in complete diets with very little inherent fat content can be exploited to dilute the negative effects of fats beyond the maximum permissible limit. Further studies however need to be conducted to assess the implications of these diets on rumen fermentation.

5. References

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Table 1

Chemical composition of feedstuffs (%)

Constituent	Ingredients				
	Maize stover (MS)	Sunflower cake (SFC)	Sunflower head (SFH)	Groundnut tops (GNT)	MS, GNT and SFH
Dry matter	95.2	96.6	94.4	93.8	94.0
Ash	5.7	5.1	14.8	8.8	11.2
Crude protein	3.5	20.5	9.3	11.2	5.7
Ether extract	3.2	34.2	7.9	2.6	5.1
Neutral detergent fibre	82.1	49.6	51.2	68.4	75.3

MS, GNT and SFH were mixed at 6:3:1 ratio, respectively.

Table 2

Mean basal diet (BD), sunflower cake (SFC) and total feed intake (TFI) of kapeters offered the same basal diet and supplemented with varying levels of sunflower cake. Relative values are expressed as a proportion of that of the unsupplemented diet.

Parameter	Dietary treatment				MSE	Sign.
	Control	15 g/kg$^{0.75}$/d	30 g/kg$^{0.75}$/d	45 g/kg$^{0.75}$/d		
BD intake d^{-1}	431.64	309.63	301.00	330.00	226698.40	NS
Index	1	0.71	0.69	0.76		
BD intake/kg$^{0.75}$/d	54.66	43.40	40.83	46.03	102.10	NS
Index	1	0.72	0.70	0.76		
SFC intake d^{-1}	-	75.66	102.84	104.98		
TFI d^{-1}	431.64	385.19	403.84	434.99	10320.60	NS
Index	1	0.89	0.94	1.01		
TFI/kg$^{0.75}$/d	54.66	55.54	55.69	61.00	59.59	NS
Index	1	1.02	1.02	1.12		

Basal diet had maize stover, groundnut tops and sunflower heads mixed in the ratio 6:3:1, respectively.

MSE = mean square error obtained from ANOVA table

Sign = significance

Table 3

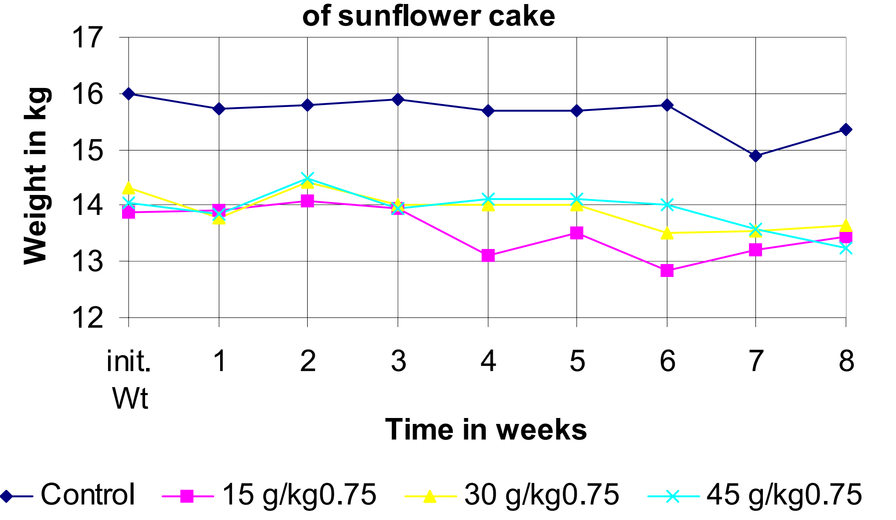
Effects of supplementation of a low quality basal diet (BD) with sunflower cake (SFC) on live body weight (kg) changes in kapeters.

Parameter	Dietary treatment				MSE	Sign.
	Control	15 g/kg$^{0.75}$/d	30 g/kg$^{0.75}$/d	45 g/kg$^{0.75}$/d		
Initial weight	16.00	13.88	14.32	14.05	9.080	NS
Final weight	14.17	13.98	13.85	13.66	1.078	NS
Body mass (BM) change	-0.385	-0.578	-0.705	-0.896	1.078	NS
BM change d^{-1}	-0.0069	-0.0103	-0.0126	-0.0160	0.00034	NS

Basal diet had maize stover, groundnut tops and sunflower heads mixed in 6:3:1 ratio, respectively.

Sign.= significance

Fi gure 1: Growth performance of kapeters offered the same basal diet supplemented with varying levels of sunflower cake



Control	16	15.74	15.8	15.88	15.7	15.7	15.8	14.88	15.34
15 g/kg0.75	13.88333333	13.91667	14.08333	13.93333	13.1	13.51667	12.85	13.2	13.43333
30 g/kg0.75	14.32	13.78	14.4	14.02	14	14.02	13.5	13.54	13.66
45 g/kg0.75	14.05	13.85	14.475	13.95	14.1	14.1	14.025	13.575	13.25
	init. Wt	1	2	3	4	5	6	7	8