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Performance of Lactating Dairy Cows Fed Dried Sardines

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إنتاجية الأبقار المدرة للحليب والمغذاة على السردين المجفف

الملخص : لاستغلال الموارد الغذائية المتوفرة محليا للإنتاج الحيواني في المناطق الحارة تم تضمين السردين المجفف في علائق الأبقار المدرة للحليب. تم استخدام أربعة عشر بقرة من سلالة الهولستين وثلاثة عشر من أبقار الزيبو الأسترالية الحلوبة متعددة الولادات في تجربة تغذية متواصل لمدة سبعين يوما . تم تقديم علائق متجانسة المحتويات من النيتروجين والطاقة، تحوي كسب فول الصويا أو السردين المجفف (بحيث يحتوي العلف على ٤٠% بروتين خام) وذلك حسب الشهية. تم إجراء المقارنات بين العلائق خلال فترة ٧ أسابيع من التجربة التي أجريت على نظام المعامل ٢× ٢ باعتبار أن العوامل الرئيسية هي الغذاء والسلالة. لم يحدث تغير يذكر في حامضية الكرش ونيتروجين الأمونيا والأحماض الدهنية المتطايرة الكلية أو الفردية نتيجة للتغذية بالسردين المجفف . كانت معدلات تناول المادة الجافة والطاقة والبروتين الخام والألياف أقل (p<٠,٠٥) في سلالتي الأبقار المغذاة على السردين الجاف . بالرغم من عدم وجود تأثير معنوي، إلا أن إنتاج الحليب كان أعلى في أبقار الهولستين المغذاة على السردين المجفف عن تلك التي غذيت على العلف العادي (١٦,٢ كجم مقارنة بـ ١٥,١كجم). لم يؤثر العلف المحتوي على السردين المجفف على تركيب الحليب والإدرار التركيبي. كان إنتاج الحليب أعلى (p<٠,٠١) في أبقار الهولوستين عنه في أبقار الأسترالية. كانت تأثيرات الغذاء والسلالة على إنتاج الحليب ذات أهمية معنوية (p<٠,٠٥). يمكن أن يكون للغذاء ذو البروتين المستخرج من البحار استخدامات مستقبلية أكثر في الأبقار عالية الإنتاج (هولستين) أكثر منه في الأبقار المنخفضة الإنتاج (الزيبو الأسترالية). لم يحدث تأثير على مؤشرات التناسل ومعاملات حالة الحيوان ومؤثرات التاثر بالإجهاد الحراري من جراء إطعام السردين المجفف. تشير هذه الدراسة إلى إمكانية إدخال السردين المجفف في علائق الأبقار الدارة للحليب دون تأثير على معدلات إنتاج الحليب.

ABSTRACT: To utilize locally available feed resources with livestock production in hot climates, dried sardines were incorporated into diets for lactating dairy cows. Fourteen Holstein and 13 Australian Milk Zebu multiparous cows were used in a 70-day continuous feeding experiment. Isonitrogenous and isoenergetic diets containing either soybean meal or dried sardines (supplied 40% of dietary crude protein) were fed ad - libitum. Comparisons between diets were made during the 7-week experimental period. The experiment was conducted as a 2 x 2 factorial arrangement of treatment, with diet and breed as main factors. Ruminal pH, ammonia N, total and individual volatile fatty acids concentrations were not altered by the feeding of dried sardines. Intakes of dry matter, energy, crude protein, and acid detergent fiber were lower ($P<0.05$) in both breeds of cows fed dried sardines. Intakes of ether extract and ash were higher ($P<0.05$) in cows fed dried sardines. Although it was not statistically significant, milk production was higher ($P>0.05$) in Holstein cows fed dried sardines than those fed the control diet (16.2 vs 15.1 kg/d). Feeding of dried sardines did not affect milk composition and compositional yields. Milk production was higher ($P<0.01$) in Holstein than Australian Milk Zebu cows. Effect of diet and breed interaction on milk production was significant ($P<0.01$). Potential of feeding marine proteins may be higher for higher milk producers (Holstein) than lower producers (Australian Milk Zebu). Reproduction parameters, body condition scores, and heat-stress associated parameters were not affected by the feeding of dried sardines. This study suggests that dried sardines could be incorporated into diets of lactating dairy cows without affecting milk production.

In arid climates such as in Oman, local feed resources available for animal production are limited. Protein and energy supplements for intensive livestock and poultry production are largely dependent upon imports. Exploitation of locally available feed resources becomes necessary for a sustainable animal production system.

There are several hundred small-pelagic fish species in Oman, of which 10 - 15 species are commonly seen in landings (Dorr, 1991). The Indian oil sardine (Sardinella longiceps) is the most abundant of the landings throughout Oman, comprising more than 95% of the total landings. According to the most recent statistics (Ministry of Agriculture and Fisheries, 1995) small pelagic landings were 41,496 tonnes annually, 80% of which were sardines. Seventy percent of total sardine landings are available for animal feed with the remaining 30% for human consumption, export and bait. Nutritive value of local dried sardines in many aspects is comparable to that of commercial fish meal. Fish meal, a by-product of the fish industry, has a high crude protein content (60 to 72%) and contains an appreciable amount of fat (3 to 11%) and ash (10 to 20%, mainly calcium and phosphorus) (Hussein and Jordan, 1991). Depending on the processing conditions and methods, fish meal is considered a protein source that can meet the growth and lactation requirements in ruminants. This is attributed to its relatively low protein degradability in the rumen and richness in essential amino acids. Dried sardines, on the other hand, contain up to 65% crude protein, 26% ash and 4 to 12% fat, and are not commercially processed. Sardines are a direct product resulting from solar drying and may be susceptible to enzymatic and microbial proteolysis, insect infestation and contamination.

Limited work had been carried out in Oman to study the feeding of dried sardines to growing ruminants and poultry. Preliminary results suggested that dried sardines could be as good as commercial fish meal for broilers (J.M. Chesworth, personal communication). Research work at the Ministry of Agriculture and Fisheries suggested that dried sardines could be incorporated (10%, as fed basis) into diets for growing ruminants (El Hag and Al-Khanjari, 1992). However, no known research has been carried out to study the effect of feeding dried sardines on milk production in dairy cows. It is known that substantial undegradable intake protein is required to support milk production in dairy cows, especially during early lactation. Furthermore, weight loss is observed in high producing dairy cows due to their inability to have sufficient feed intake to meet the energy requirement. Because of its nutritive value and abundance in Oman, dried sardines may be considered as an alternative to meet the protein and energy requirements of lactating dairy cows. Therefore, a lactation trial was carried out to study the effects of feeding dried sardines on intake, milk production and body weight changes in two breeds of dairy cows.

Materials and Methods

ANIMALS AND TREATMENTS: Fourteen Holstein and 13 Australian Milk Zebu (AMZ) multiparous cows were grouped according to age, calving date, parity, and preceeding milk production, and assigned randomly to one of two dietary treatments. Holstein cows averaged 56 days and Australian Milking Zebu (AMZ) 73 days postpartum. The experimental diets contained either soybean meal (SBM) or dried sardines (DS) which provided 40% of dietary crude protein. Dried sardines were purchased from fishermen on the Batinah Coast where they are traditionally dried on the beach for 4 to 5 days in the summer and for about 7 days in the winter. Dried sardines containing (DM basis) 52.7% (38.6 - 63.8) crude protein, 5.4% (4.8 - 6.5) fat, and 34.6% (22.2 - 50.8) ash were ground through a P. Breaker grinder (Model no. PB15R6248-2, Hosokawa Rietz Ltd., Buck Heaven, UK) prior to mixing with other feed ingredients. Experimental diets were formulated to be isonitrogenous and isoenergetic and contained 1.60 Mcal/kg DM net energy for lactation (NEL), 16% crude protein, 40% neutral detergent fiber, 0.8% calcium and 0.5% phosphorus. Calculations of nutrient contents of total ration were based on the National Research Council (1988) requirements for milk production and estimated dry matter intake of the previous lactation. Two concentrate mixtures were prepared using either SBM or DS as the main protein source. Concentrate and hay were mixed according to the ratio established for the total ration (Table 1) prior to feeding. Except for SBM and DS, the chemical composition of ingredients used for ration formulation was based on tabular values (NRC, 1988). Crude protein, gross energy, ether extract, crude fiber, neutral detergent fiber, acid detergent fiber and ash of DS and SBM were chemically determined prior to ration formulation. The ration was balanced using Mixit2 computer software (Agricultural Software Consultants Inc., Kingsville, Texas, USA).

TABLE 1

Ingredients of experimental diets containing soybean meal (SBM) and dried sardines (DS)

	Diet	
Ingredients, % of DM	SBM	DS
Rhodegrass hay, chopped	40	40
Barley, rolled	34	23.5
Corn, cracked	2.2	14.5
Whole, cottonsead	8	8
Soybean meal, 44% CP	12.4	-
Sardines, solar dried	-	12
Sodium bicarbonate	1	1
Vitamin-mineral mix[1]	0.4	0.4
Salt	0.4	0.4
Limestone	1	0.1
Calcium phosphate	0.4	-

[1]Contained 2,000,000 IU of vitamin A, 500,000 IU of vitamin D, and 1,250 IU of Vitamin E/kg; 0.5 g Co, 5 g Cu, 1.3 g I, 5 g Fe, 125 g Mg, 20 g Mn, 0.04 g Se and 10 g Zn/kg.

FEEDING, DESIGN AND SAMPLING: Cows were fed twice daily (800 and 1400 h) using a Calan-Broadbent Feeding System (American Calan, Northwood, New Hampshire, USA). Orts, 5% of feed offered, were collected, weighed and sampled. Feed samples were collected weekly and milk samples at 600 and 1600 h weekly. Ruminal samples were collected via a stomach tube at 2 to 4 h postprandial during week 5 of the experiment. The experiment consisted of a 3-week adjustment and a 7-week experimental period. Two cows in the DS group left the trial before the end of the experiment due to metabolic disorders. Following a 2 x 2 factorial arrangement of treatment, the randomized block experiment consisted of uneven number in breed (Holstein, n = 14; AMZ, n = 13) and in treatment (SBM, n = 13; DS, n = 14). Body weights were recorded weekly prior to feeding throughout the entire experiment. Estrus cycles were synchronized using prostagladin $F_{2\alpha}$ 4 weeks after the initiation of the experiment. Cows on estrus were artificially inseminated and the rest were again synchronized 2 weeks later and inseminated. Thereafter all the non-pregnant animals were bred by artificial insemination on observed estrus until confirmed pregnant. Pregnancy was confirmed by rectal palpation 40 days after breeding. Respiration rate and rectal temperature were measured biweekly at the condition when the temperature and humidity index (Bianca, 1962) was approximately 75.

CHEMICAL AND DATA ANALYSIS: Dry matter content was determined by oven drying at 80°C for feed samples. Gross energy was determined by ballistic bomb calorimetry. Total nitrogen was determined by the macro-kjeldahl, fat by ether extraction, crude fiber by dilute acid and alkali, and ash by using a muffle furnace at 550°C overnight (AOAC, 1990). Acid detergent fiber was determined by the Goering and Van Soest method (Goering and Van Soest, 1970). Ruminal pH and ammonia nitrogen (NH_3-N) were determined by a previously described method (Everson *et al.,* 1971). Rumen fluid samples were prepared for volatile fatty acids (VFA) analysis by GC with certain modifications according to GC Bulletin # 856, 1990 (Supelco Inc., Bellefonte, PA, USA). Five milliliters of strained rumen fluid was pipetted into a centrifuge tube. One ml of 25% metaphosphoric acid was added, mixed thoroughly and allowed to stand for 30 min at room temperature. The mixture was centrifuged at 5000 rpm (Beckman Instruments Inc., Fullerton, CA, USA) using a JA-14 rotor for 10 min. The supernatant was filtered through a 0.45μm nylon filter before injecting into the GC. The volatile fatty acids were analyzed using Hewlett Packard HP5890 series II plus GC coupled with HP5989B MS engine (Hewlett Packard Company, Palo Alto, CA, USA). Peaks were identified by retention time as compared to reference standard and re-confirmed by computer library of mass spectra. The volatile fatty acids were separated on a cross-linked Polyethylene Glycol-TPA (HP-FFAP, Hewlett Packard, Milian, Switzerland) capillary column (30 m x 0.32 mm). The analysis of VFA was carried out under following conditions: injector temperature 200°C; oven initial temperature 60°C (with increasing rate of 5°C/min up to 150°C and 20°C/min thereafter); final temperature 230°C; final time, 5 min; and carrier gas helium with 39.8 cm/sec linear velocity. One microliter sample was injected using HP6890 autosampler and injector (Hewlett Packard Company, Palo Alto, CA, USA). The volatile fatty acid peaks were quantified using octanoic acid (Alltech, Deerfield, IL, USA) as the internal standard. Response factor of each VFA was calculated using a 0.1% free fatty acid mixture (Alltech, Deerfield, IL, USA). Milk protein was calculated as Kjeldahl N x 6.38 and milk fat was determined (Richardson, 1985) using weekly a.m. - p.m. composite milk samples. Data were analyzed using the general linear models procedure of the statistical analysis system (SAS, 1996), where animal age, parity and days postpartum were used as covariates.

TABLE 2

Chemical composition (dry matter basis) of the concentrate mixtures containing soybean meal (SBM) or dried sardines (DS), and rhodesgrass hay (HAY)

Item	Diet		
	SBM	DS	HAY
Dry matter, %	89.5	88.9	90.3
Crude Protein, %	20.5	20.5	7.5
Gross energy, MJ/kg	17.4	16.7	17.1
Ether extract, %	3.1	4.9	2.8
Nitrogen free extract, %	64	61.7	50.1
Total CHO, %	69.1	63.1	80
Crude fiber, %	6.4	4.7	31
Acid detergent, fiber %	9.7	9.3	34.6
Lignin, %	0.98	0.97	4.79
Ash, %	7.4	11.4	9.7

Results and Discussion

The concentrate mixtures were isonitrogenous and isoenergetic (Table 2). In a separate digestion trial using sheep, apparent digestion coefficients of gross energy were 66 and 64% for the SBM and DS diets (chopped rhodes grass hay: concentrate = 50:50),

TABLE 3

Ruminal components of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed isonitrogenous and isoenergetic diets containing soybean meal (SBM) or dried sardines (DS)

Item	SBM		DS		Probability[1]			SEM
	HOL	AMZ	HOL	AMZ	Diet	Breed	D x B[2]	
pH	7.12	7.2	7.3	7.43	NS[2]	NS	NS	0.07
Ammonia N, mg/dl	17	15.5	18.6	16.6	NS	NS	NS	0.9
VFA, m/M								
Total	138	135	127	120	NS	NS	NS	12
Acetate	92.7	88.7	85.6	78.5	NS	NS	NS	8
Propionate	23.2	23.5	21.2	20.5	NS	NS	NS	2.4
Butyrate	16	16.7	14.3	15.2	NS	NS	NS	1.5
Isobutyrate	1.6	1.6	1.6	1.8	NS	NS	NS	0.2
Valerate	2.5	2.4	2	2.2	NS	NS	NS	0.3
Isovalerate	2.2	2.2	2.3	2.3	NS	NS	NS	0.2
A: P[3]	3.9	3.8	4	3.9	NS	NS	NS	0.1

[1] NS, not significant ($P>0.05$). [2] DxB, diet and breed interaction. [3] Acetate to propionate ratio.

respectively (R.J. Early, Personal Communication). Ether extract and ash contents were higher in the concentrate mixture containing DS (Table 1). This is attributed to the higher ether extract and ash in the solar-dried sardines. Nitrogen free extract, total CHO, crude fiber, acid detergent fiber, crude fiber, and lignin contents were similar in the two concentrate mixtures. Locally grown rhodesgrass hay was low in protein (7.5% CP) and digestible energy (58%) and high in fiber (34.6% acid detergent fiber). Based largely on the predetermined forage to concentrate ratio of 40 to 60 (Table 1), the total diet provided 15.2 to 15.7% CP, 18.4 to 20.2% acid detergent fiber, 14.2 to 16.8% crude fiber, and 2.8 to 4.1% ether extract for the two breeds of cows fed either the SBM or DS diet.

Ruminal pH and NH_3-N concentrations were similar between treatments (Table 3). Fish meal is largely considered more resistant to microbial degradation in the rumen than some plant protein sources (NRC, 1985). However, the solar-dried sardines did not seem to possess the same characteristics as that of fish meal. One would normally expect a lower NH_3-N concentration in the rumen in animals fed the diet containing a protein source more resistant to ruminal degradation. We speculate that sardines dried with solar energy in an open environment might be subjected to microbial proteolysis during the process of drying. We also recognize that ruminal NH_3-N is not the only indicator for protein degradation. It may be useful to employ in situ (Lu *et al.*, 1981) or in vitro (Lu *et al.*, 1982) methods to determine the protein degradability of DS in the future.

There were no effects ($P>0.05$) of diet, breed or diet and breed interaction (D x B) on ruminal concentrations of individual and total volatile fatty acids. Concentrations of total volatile fatty acids were slightly higher than those of recent studies (Lu *et al.*, 1997; Abel-Caines *et al.*, 1998). It is thought that both SBM and DS diets were highly fermentable and microbial synthesis was not limited by the availability of NH_3-N or fermentable carbohydrate in the rumen. Acetate to propionate ratios, ranging from 3.8 to 4.0, were not affected by diet, breed or D x B. Milk fat precursors, acetate and butyrate, were perceived as high enough to sustain the milk fat synthesis in the mammary gland.

Dry matter intake (DMI) was higher ($P<0.05$) in cows fed the SBM than the DS diet (Table 4). The magnitude of difference attributed to the dietary treatment was 3% or 0.4 kg/d in Holstein and 6% or 0.7 kg/d in AMZ cows. Numerically the difference was 6% or 0.55 kg/d between breeds and 4.5% or 0.75 kg/d between diets. Because of lower levels of milk production in AMZ cows, one would expect a lower DMI. Under the hot climate of Oman, heat-resistant breeds like AMZ are presumably less susceptible to reduction in DMI due to heat stress as compared to the Holstein. This explained partially that the expected breed difference in DMI was counterbalanced by the variable response to heat stress between breeds. Intakes of crude protein, crude fiber, ether extract, ash and gross energy were lower ($P<0.01$) in cows fed the DS diet. Intake of acid detergent fiber was also lower ($P<0.05$) in cows fed the DS diet. There was no significant breed difference ($P>0.05$) in intake of these constituents. These differences were attributed to lower DMI in cows fed the DS diet. We speculate that the high proportion of DS in the total diet (12.0% of total dry matter) might have resulted in a diet which

TABLE 4

Nutrient intake of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed isonitrogenous and isoenergetic diets containing soybean meal (SBM) or dried sardines (DS)

	SBM		DS		Probability[1]			
Item	HOL	AMZ	HOL	AMZ	Diet	Breed	D x B[2]	SEM
Dry matter, kg/d	13.2	12.6	12.8	11.9	*	NS	NS	0.3
Crude protein, g/d	201	204	196	187	**	NS	NS	5
Acid detergent fiber, g/d	266	245	256	219	*	NS	NS	9
Crude fiber, g/d	222	199	201	169	**	NS	NS	8
Ether extract, g/d	37.5	40.8	52.7	48.5	**	NS	**	1.2
Ash, g/d	106	112	140	127	**	NS	**	3
Gross energy, Mcal/d	231	224	218	200	**	NS	NS	6

[1]* $P<0.05$; ** $P<0.01$; NS, not significant. [2] D x B, diet and breed interaction.

TABLE 5

Milk production and composition of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed isonitrogenous and isoenergetic diets containing soybean meal (SBM) or dried sardines (DS)

	SBM		DS		Probability[1]			
Item	HOL	AMZ	HOL	AMZ	Diet	Breed	D x B[2]	SEM
Milk, kg/d	15.1	12	16.2	11.1	NS	**	**	0.5
pH	6.71	6.73	6.77	6.74	*	NS	NS	0.02
4% FCM, kg/d	14.5	11.6	15	11.2	NS	**	NS	1.39
Total solids								
%	12.09	12.92	11.89	13.51	NS	**	*	0.27
Kg/d	1.83	1.56	1.92	1.49	NS	**	NS	0.46
Fat								
%	3.72	3.73	3.53	4.04	NS	NS	*	0.17
Kg/d	0.56	0.45	0.57	0.45	NS	**	NS	0.15
Protein								
%	3.09	3.46	2.89	3.51	NS	**	NS	0.05
Kg/d	0.47	0.42	0.47	0.39	NS	**	NS	0.03
Lactose								
%	4.57	4.99	4.76	5.23	NS	**	NS	0.11
Kg/d	0.69	0.6	0.77	0.58	NS	**	NS	0.02
SNF								
%	8.37	9.19	8.36	9.47	NS	**	NS	0.13
Kg/d	1.27	1.11	1.35	1.05	NS	**	*	0.29

[1]* $P<0.05$; ** $P<0.01$; NS, not significant. [2] D x B, diet and breed interaction.

was less palatable to the cows and a longer adaptation period might have been required. There was a distinct fishy smell in the DS diet. During the course of experiment, samples of DS were analyzed for any possible pathogenic microbial contamination and were found to be negative, this excluded the possible effect of pathogenic contamination on feed intake. Higher intakes of ether extract and ash in cows fed DS were largely due to the composition of dried sardines. Effects of D x B were significant ($P<0.01$) in intakes of ether extract and ash. Dietary differences in intakes of ether extract and ash were less profound in AMZ than in Holstein cows. This of course, attributed to the lower DMI of AMZ and the higher ether extract and ash contents in DS. In Holstein cows, differences in DMI due to dietary treatments were observed in the

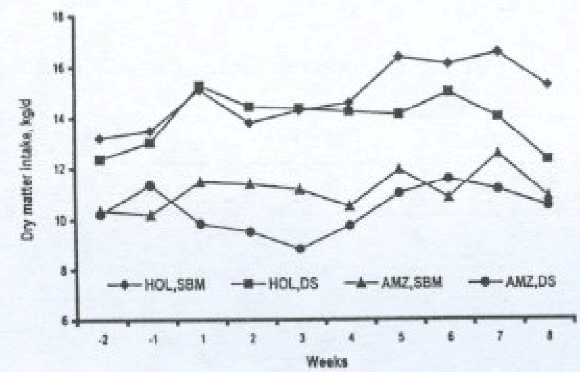

Figure 1. Dry matter intake of Holsteins (HOL) and Australian Milk Zebu (AMZ) cows fed the soybean (SBM) or dried sardine diet (DS)

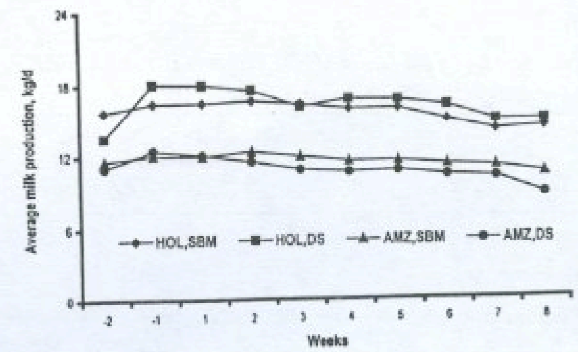

Figure 2. Lactation curve of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed the soybean (SBM) or dried sardine diet (DS)

later part (week 5 to 8) of the experiment (Figure 1). In AMZ cows, the difference in DMI due to the dietary treatment was observed in the beginning of the experiment and continued until the end of the experiment.

Milk yield, total solids, fat, protein, lactose and solids-not-fat content and yield were not affected ($P<0.05$) by the feeding of DS (Table 5). Milk in the cows fed SBM was more acidic ($P<0.05$) than those fed DS. However, the difference may not be biologically significant.

Milk yield was influenced by breed and D x B ($P<0.01$). As expected, Holstein cows produced more milk than AMZ. Holstein cows fed DS produced more milk than those fed SBM diet. On the other hand, milk yield was less in AMZ cows fed DS as compared to those fed SBM. Holsteins produced more 4% FCM than AMZ cows, and the effect of D x B was not significant ($P<0.05$). With the exception of fat content, breed had a profound effect on milk composition and compositional yields. AMZ had higher ($P<0.01$) total solids, protein, lactose and SNF content than Holstein cows. Because of the lower milk yields in AMZ the compositional yields (total solids, fat, protein, lactose, SNF) were also lower ($P<0.01$), regardless of concentration of these contents in the milk. Effects of D x B on total solids (%), fat (%) and SNF (kg/d) were significant ($P<0.05$). Total solids and fat content were higher in AMZ cows fed DS than SBM. The reverse was observed in Holstein cows. Holstein cows fed the DS diet produced more SNF than those fed the SBM diet, and the reverse was observed in AMZ cows. Although the level of milk production in the present experiment cannot be considered as high, we did observe a trend which suggested that feeding of DS might be beneficial for higher producers like Holsteins. Nevertheless, we speculate that the DS diet has the potential to provide a better quality and a larger quantity of protein for intestinal absorption, and subsequently support greater milk production. If nonsolar processing conditions were employed, such as chemical or heat treatment, DS can be modified to be more resistant to protein degradation in the rumen and therefore provide a greater intake of undegradable protein for lactation (Lu, *et al.*, 1983). Milk yield in Holstein cows receiving the DS diet was slightly higher throughout the experiment, except for week 3 (Figure 2). On the contrary, milk yield in AMZ cows receiving the SBM diet was consistently higher throughout the experiment. It appears that body weight was not affected by the dietary treatment (Figure 3).

At the beginning of the experiment, there was a strong concern that feeding of DS might alter the flavor of milk. It has been recognized that the concentration of certain fatty acids contributes to the flavor of milk (Lu, 1993). Although the fatty acid profile in the milk was not chemically determined, random organoleptic evaluation revealed no detectable difference in milk flavor from cows fed either SBM or DS diet.

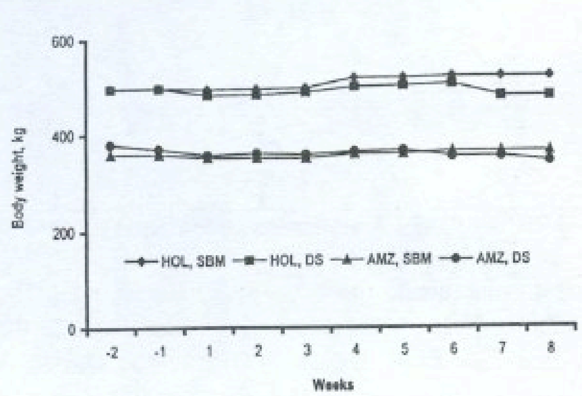

Figure 3. Body weight changes of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed the soybean (SBM) or dried sardine diet (DS)

TABLE 6

Reproductive parameters, body condition scores and heat stress associated parameters of Holstein (HOL) and Australian Milk Zebu (AMZ) cows fed isonitrogenous and isoenergetic diets containing soya bean meal (SBM) or dried sardine (DS)

	SBM		DS		Probability[2]			
Item	HOL	AMZ	HOL	AMZ	Diet	Breed	D x B	SEM
Post partum. d	75.9	53.3	70.4	58.4	NS	*	NS	4.2
Conception rate, %	89	99	99	95	NS	NS	**	0.1
Body condition score[1]	1.48	2.70	1.52	2.72	NS	**	NS	0.12
Respiration rate, x/min	44	43	46	42	NS	NS	NS	3
Rectal temperature, °C	102.4	101.9	102.7	101.1	NS	NS	NS	0.3

[1] Score on a five-point scale where 1 = emaciated to 5 = overly fat (Peters and Ball, 1987).
[2]* $P<0.05$; **$P<0.01$; NS, not significant.

Feeding of DS did not affect overall conception rate (CR), body condition score, respiration rate and rectal temperature (Table 6). Body condition scores were lower ($P<0.01$) in Holstein than those of AMZ cow. This suggested that more nutrients were mobilized from the body tissue of Holstein cows to support the demand for milk production. This is somewhat unexpected because the level of milk production in this experiment was not high enough to reach the point which animals started losing weight. There was a D x B effect ($P<0.01$) on CR, with Holstein cows fed the DS diet having higher CR than Holsteins fed the SBM diet. The biological significance contributed by DS on CR may not be apparent, since the overall CR in both groups approached 90% or above by the end of the experiment. Numerically, the AMZ cows had lower respiration rate and rectal temperature than Holstein cows ($P>0.05$). These are indications that DS can be utilized by lactating dairy cows without any adverse effect on reproduction.

Conclusions

Locally available sardines can be incorporated into diets (12% of DM in this study) of lactating dairy cows. With the exception of lower DMI, feeding DS did not cause any adverse effects on ruminal fermentation and reproduction. As expected profound breed differences were observed in milk production and composition.

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