ISSN 2347-4289

Effects Of Dietary Supplementation With Urea Molasses Multi-Nutrient Block On Performance Of Late Lactating Local Ethiopian And Crossbred Dairy Cows

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Abstract: An experiment was conducted on station, using a nested design in order to evaluate the effects of a Urea Molasses Multi-Nutrient Block (UMMB) supplementation of typical dry season, roughage based diets on the performance of second and third lactation local Fogera (Zenga) and their F_1 Holstein Friesian crossbred cows in Ethiopia. Within each breed, cows were assigned either to a forage-based control diet or an experimental diet that was supplemented with UMMB, thereby creating four different treatments. During this experiment, cows were in late stage lactation and the diets supplied 35 and 40 MJ ME together with 380 and 517 g CP for control and supplemented Fogera cows, respectively and 47 and 54 MJ ME with 546 and 738 g CP for control and UMMB supplemented crossbred cows, respectively. A total of 16 lactating dairy cows (8 control and 8 supplemented) per breed were used for both experiments. Significant differences were observed between treatments on traits like saleable milk offtake, energy corrected milk, fat content of milk, and daily offtake of milk fat, milk protein and milk energy. For the milk and milk energy offtake, reproductive performance and benefit-cost ratio, the crossbred dairy cows were performing better than their Fogera counter parts regardless of the nutrient supply. Conversely, for milk quality traits the Fogera cows were superior to the crossbred cows. Supplementation with UMMB did not influence all the traits studied herein in the same manner in the different breeds. UMMB supplementation obviously allowed the crossbred cows to better express their greater genetic potential for milk production as compared to Fogera. The opposite was the case for milk fat content. From the data presented here, it is concluded that supplementing dairy cows with UMMB during the dry season is basically a helpful measure to maintain a satisfactory level of production and to improve important economic traits of milk production in Ethiopia. Depending on the availability of UMMB, priority in supplementation should however be given to cows with a high genetic potential for milk production.

Keywords: Crossbred -Dairy cow -Fogera -Molasses -Supplement -Urea

Introduction

Farmers in the tropics and developing countries often rely on the use of exotic genotypes to crossbreed their indigenous cattle with the aim to improve their milk yield. Because of the specific environmental stressors, including climatic factors, pathogen pressure and deficient feed supply, the performance of the animals originating from such a crossbreeding program often falls substantially behind the expectations, eventually indicating a genotype by environment interaction (Phung, 2009). On the other hand, the traditional smallholder production systems which are largely dependent on low yielding indigenous breeds contribute 97 % of the total national milk production and 75 % of the commercial milk output in Ethiopia (Ahmed et al., 2004). Despite its socio-economic contribution, the dairy sector in tropical countries, including Ethiopia is frequently challenged with various constraints. Among these, nutritional limitations are often the overriding ones and a concern in livestock development strategies (Nyambati et al., 2003; ELDMPS, 2007; Asaminew and Eyassu, 2009; Belete et al., 2009; Mendieta-Aracia et al., 2011). According to these sources, the basal diets of ruminants during the dry season are fibrous crop residues and pasture, which are low in their nutritional contents. On the other hand, insufficient intake of energy, protein and minerals is associated with sub-optimal productive and reproductive performance of dairy cows (Indetie, 2009). An average 35 % deficiency in feed supply can be expected in Ethiopia even during normal years and this figure may rise to 70 % during draught years (ELDMPS, 2007). This problem is likely to become more serious as a growing human population demands more land for crop production. The main reasons for feed shortage in Ethiopia are therefore related to shrinking grazing lands as a result of expansion of arable cropping; the low contribution of improved forage as livestock feed (0.25 % ; CSA, 2010) and high prices of concentrates which further exacerbate the tight situation (Asaminew and Eyassu, 2009; Belete et al., 2009; Dejene et al., 2009; Teshome, 2009). On the other hand, large amounts of molasses have been produced as by-product of sugar in four sugar factories in Ethiopia and its supply is expected to substantially increase in the near future due to the expansion of the existing factories and a number of new plants currently under construction and in the planning phase (Adugna, 2007; GTP, 2010). After promotion by the government, a part of the molasses is used for ethanol production in the country. However, so far this applies mainly to molasses produced in one of the four large sugar processing plants, Fincha Sugar Industry (Ethiopian Sugar Corporation, personal communication). Addressing the nutritional problem, molasses in the form of Urea Molasses Multi-Nutrient Blocks (UMMB) were used as a livestock feed supplement in a number of countries and several studies showed positive effects on productive and reproductive performance plus an attractive benefit-cost ratio for both local and crossbred dairy cows (Sudhaker et al., 2002; Misra et al., 2006; Sahoo et al., 2009). If UMMB are to be used as dietary supplements, it should be kept in mind that the response of dairy cows to an increased nutrient supply depends on several factors, such as the

ISSN 2347-4289

cows' genetic potential, stage of lactation and the related feeding level, feed quality and climate (Wiktorsson, 1979). In addition, breeds which were developed in distinctly different environments may not perform similarly in other settings, particularly under different feeding regimes, indicating a genotype by environment interaction. Therefore, this study was conducted to test the hypothesis that cows of two different breeds (Fogera, a local Ethiopian dairy breed and F_1-Fogera * Holstein Friesian crosses) differ in terms of productive and economic performance, regardless of UMMB supplementation in their late stages of lactation. Furthermore, the hypothesis is tested that, for both breeds, UMMB supplementation improves the performance traits mentioned above.

1. Materials and methods

1.1. Design of the experiments

This study was conducted on station using a nested design on sixteen dairy cows of each breed (local Fogera and Fogera * Holstein Friesian crossbred, F_1). These sixty cows further divided into two groups of 8 cows each and were fed either a control diet consisting of forage and concentrate or the control diet plus UMMB as a supplement. Cows were in their second and third lactation. The study was carried out at Andassa Livestock Research Center (ALRC), Amhara Region, Ethiopia. ALRC is located at $11^0$29´N latitude, $37^0$29´ E longitude, at an altitude of 1730 meter above sea level. The annual average rainfall at the center is 1150 mm and the mean minimum and maximum temperatures during the experiments were 9 and 34^0C, respectively (December-May). This experiment was conducted during the dry period using late stage of lactation cows of both breeds. The four treatments used for both the experiments were Fogera cows fed the traditional diet as a control (FN), Fogera cows fed the control diet plus UMMB as experimental group FS, crossbred cows fed the control diet (CN) and crossbred cows fed the control diet plus UMMB as experimental group CS. Apart from the nutrient supply and stage of lactation, the experimental design and management were similar to the experiment which was conducted using similar breed, number of cows and similar intervention diet (Tekeba et al., 2013) in which cows remaining in the same treatment. The dietary energy and protein levels were adjusted based on the milk yield and change in body condition of the two breeds during the first experiment. Accordingly, 35 and 40 MJ ME with 380 and 517 g CP were planned to be supplied to Fogera cows in the control (FN) and the supplemented group (FS), respectively. The crossbred cows were offered 47 and 54 MJ ME with 546 and 738 g CP for the control (CN) and supplemented group (CS), respectively.

1.2. Cow management and feeding

Cows were housed individually in a well-ventilated, open barn in tie-stall pens with concrete floor. Prior to the experiment, cows were treated for internal and external parasites and were vaccinated for Anthrax and Bovine Pasteurellosis. Postpartum oestrus activity was monitored daily by a researcher, veterinarian, herd attendants and with the help of a teaser bull. Before milking, calves were allowed to suckle for about 1 minute to initiate milk letdown and again after milking. Cows were milked twice daily by hand and milk offtake was recorded at each milking period. The daily basal diets during the experiment consisted of baled hay (ad libitum), freshly harvested Napier grass (4 kg/cow), and 1 kg of homemade dairy concentrate/cow (74 % wheat bran, 25 % nug (Guizotia abyssinica) seed cake, 1 % common salt) for the crossbred dairy cows. For the Fogera cows, similar amounts of the basal diets were fed to both breeds, but concentrate was ceased from the Fogera cows. One bale of hay, weighing between 18 and 25 kg was offered to an individual cow and was consumed over a period of 3 to 4 days. The daily hay offer depended on the consumption level of individual cows. As soon as about 20 % of the previously offered hay was left, additional hay was given from the same bale. Hay was offered throughout day time (6 am to 7 pm). The remains were collected every morning as refusals before additional feed was offered. Samples from the refusals were taken every morning and were pooled for analysis. The hay consisted of grasses such as Andropogon abyssinicus, Cynodon dactylon, Digitaria abyssinicus and of legumes such as Trifolium quartinianum, Trifolium polystachyu and Indigofera atriceps. Four kg of Napier grass (Pennisetum purpureum) were offered to individual cows at around 10 am. Homemade concentrate was offered after morning milking (8 am) for the crossbred cows. The supplemented groups were offered UMMB in addition to the basal diets. Cows were allowed to lick the block between 10 am and 5 pm, after which the blocks were collected. During this time, a cow was assumed to consume about 500-700 g UMMB. UMMB were formulated from 37 % molasses, 10 % urea, 10 % cement, 25 % wheat bran, 15 % nug seed cake and 3 % common salt Bediye et al. (2009). Using this formula, a 5 kg block was produced by thoroughly mixing the exact quantities of the components. Cement and salt were dissolved in 200 ml of water prior to being added to the other components. The mixture finally had a dough texture and was put into a plastic sheet lined, rectangular wooden frame of 30*20*20 cm depth, length and width, respectively, for molding. Compaction was applied using a wooden bar; afterwards the block was left for 15 minutes until it maintained a proper shape. Finally, it was removed from the frame and left to dry in a well ventilated room for about 72 hours, after which it was ready for feeding. Cows had access to fresh water from the nearby river two times per day.

1.3. Data recording

After two weeks adaptation period, data were collected for daily milk offtake, intake of all feedstuffs pooled over a one week period, estimated body weight and body condition every two weeks. Representative individual milk samples of 25 ml were taken in triplicates every two weeks for a rapid analysis of milk composition using a Lactoscan milk analyzer (Milkotronic Ltd, Nova Zagora Bulgaria[1]). Body weight was estimated from heart girth measurement on the cows every two weeks by using the regression formula developed at ALRC (Addisu, 2010):

$$\text{Body weight} = 2.126 * \text{heart girth (cm)} - 87.39 \quad (1)$$

At the same time, Body Condition Scores (BCS) were estimated by two independent observers and the mean was recorded as the body condition of the cows. Body condition

ISSN 2347-4289

estimation was done according to the procedure designed by Rodenburg (2000), using a scale from 1 (very thin) to 5 points (over conditioned) which combined both visual and tactile appraisals. Cows coming into heat were recorded for both breeds as it was occurred. Protein and energy conversion ratios were calculated using protein and energy intake over milk protein and energy offtake. Offtake of Energy Corrected Milk (ECM) was calculated using the formula by Tyrrell and Reid (1965, equ.2):

ECM = Milk yield (40.72 (% fat) + 22.65 (% protein) + 102.77)/314 (2)

Milk energy offtake was calculated based on an equation published by Tyrrell and Reid (1965, equ. 1):

MEO = ((0.0384 fat + 0.0223 protein + 0.0199 lactose – 0.108) * milk offtake) (3)

Where, MEO = Milk energy offtake (MJ/d) and units for fat, protein and lactose in milk are g/kg and milk offtake is in kg/d. Nutrient analysis for all feed components and refusals were made by taking representative samples from each feedstuffs and employing the standard method of Near-Infrared Spectroscopy (NIRS) as used in the feed laboratory at Holetta Agricultural Research Centre (Fekadu et al., 2010). The Metabolizable Energy (ME) content of each feedstuff was estimated, using a formula published by MAFF (1984):

ME (MJ kg^{-1} DM) = DOMD * 0.015 (4)

Where, DOMD = Digestible Organic Matter in Dry Matter (g kg^{-1}DM) Results from feed analysis (Table 3, annex 1) were used to calculate the Organic Matter, Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) intake which are presented in Table 1. Data on variable costs and price of milk were collected for partial budgeting. Prevailing market prices for feed ingredients and milk during the experimental period were used to calculate net return/cow/day, net return/l of milk, feed costs/l of milk and benefit-cost ratios. Net return/cow/day was calculated as the difference of daily milk sold per cow minus daily feed costs per cow. Feed costs/l of milk was calculated using feed costs per day divided by milk offtake/day. The benefit-cost ratio was calculated from change in net return between the control and supplemented diet during the experiment divided by change in feed costs.

1.4. Statistical analysis

Data for milk offtake, milk composition, feed and nutrient intake, milk energy offtake, energy and protein conversion ratio, net return/cow/day, net return/l of milk, feed costs/l of milk, estimated body weight gain, BCS, OM, NDF and ADF were analyzed using the Mixed Linear Model procedure of SAS (2009). The postpartum oestrus was analysed using Chi-Square test and benefit-cost ratios were analysed using descriptive statistics. Treatment was included in the model as independent variable, days in milk, estimated initial body weight as co-variables. Tukey-Kramer test was used to separate least square means. Significance was defined as $P < 0.05$ unless stated otherwise. The statistical model used for data analysis was:

$$Y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + X + \varepsilon_{ijk}$$

Where

Y_{ijk} = milk offtake, milk constituents, feed and nutrient intake and conversion, daily gain, BCS, cost and return, OM, NDF and ADF intake

μ = overall mean

α_i = fixed effect of i^{th} treatment (i = FN, FS, CN, CS)

$\beta_{j(i)}$ = random effect of j^{th} cow within i^{th} treatment

X = days in milk and estimated initial body weight as co-variables

ε_{ijk} = experimental error

The occurrence of heat was analysed using Chi-square test and benefit-cost ratios were subjected to descriptive statistics.

3. Results and discussion

3.1. Milk production, postpartum oestrus, feed intake and conversion

The milk production performance of dairy cows was significantly ($P < 0.05$) improved by UMMB supplementation by 0.6 (43 %) and 1.65 (52 %) liter per cow and day for Fogera and crossbred dairy cows, respectively (Table 1). Despite the differences between experiments in dietary concentrate proportion and hence in the nutrient supply, both the Fogera and crossbred dairy cows responded positively to UMMB supplementation by a 50 % and 54 % increase in energy corrected milk offtake, respectively. However, between mid (Tekeba et al., 2013) and late stage of lactation, a 14 % and 2 % drop in energy corrected milk offtake were observed in FS and CS cows, respectively. The greater persistency in daily milk offtake of crossbred dairy cows as compared to their Fogera counterparts may have contributed to this. Kabir and Islam (2009) also reported that the lactation length of local cows is much shorter than that of crossbred cows. In line with this, Addisu et al. (2010) reported a lactation length of 292 days for Fogera cows, whereas Demeke et al. (2000) reported 374 days of lactation for crossbred cows in Ethiopia. Besides an increase in daily milk offtake, all the UMMB supplemented cows had a significantly ($P < 0.05$) improved butter fat content as compared to the control. However, the rate of increase in milk fat content of FS cows in this experiment was greater than that of CS cows (Table 1). Similar to the results presented here, local Boran (Bos indicus) were found to have higher contents of milk fat, protein and total solids as compared to their crosses with Holstein Friesian (Mesfin and Getachew, 2007; Aynalem et al., 2008). Similar to the results of this experiment, Khan et al. (2007) and Misra et al. (2006) also reported that UMMB supplementation did not affect milk protein content. Despite the different stage of lactation and the related changes in

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dietary nutrient supply, there was again no significant effect of UMMB supplementation on milk protein content. Effects of dietary protein content on milk fat and protein percentage were also analyzed by Sinclair et al. (2009). In their report, multiparous Holstein dairy cows fed low protein diets had a significantly higher milk fat content, while milk protein percentage was not affected by level of dietary protein. In agreement with (Tekeba et al., 2013) result, supplementation had a significant (P ≤ 0.05) effect on milk energy offtake during this experiment. However, despite a decline in daily milk offtake during late stage of lactation, the differences in milk energy offtake between control and UMMB-supplemented cows was very similar for both breeds: 53 % vs. 51 % for Fogera and crossbred cows, respectively. Besides the observed changes in milk production traits, most of the supplemented cows showed symptoms of heat earlier than cows in the control groups. Behavioral oestrus was observed in 38 % and 75 % of the FS and CS cows, respectively. Conversely, only 25 % of the FN and 13 % of the CN cows came into heat. UMMB supplementation apparently had a greater effect in crossbred as compared to Fogera cows. However, due to the low number of observations, no statistical analysis was performed on this trait. Brar and Nanda, 2007, also reported that when buffaloes cows were supplemented with urea molasses multi-nutrient block, 40 % buffaloes showed behavioral oestrus as compared to 10 % in the control group. As opposed to the results of Tekeba et al., 2013, no significant breed effect was found on estimated body weight gain between treatments. However, due to supplementation a numerical increment in estimated body weight gain was observed for both breeds as compared to their respective control groups (Table 1). This is also partially reflected in a 17 % significant (P ≤ 0.05) improvement in BCS of FS as compared to FN cows. The 13 % difference in BCS observed between CN and CS cows did not reach the level of significance (P = 0.14). In agreement with the present findings, Upreti et al. (2010) reported that supplementation of crossbred dairy cows with UMMB during the dry season improved the body condition of the cows from score 3.5 to 4 in Nepal. Similar to the productive traits, supplementation with UMMB had a significant (P ≤ 0.05) effect on total dry matter and hay intake. However, in relative terms, the Fogera cows had a greater response for hay intake as compared to crossbred cows (29 % vs. 9 %; Table 1). During the first phase of the experiment the increment was only 8 % and 6 % for Fogera and crossbred cows, respectively. A reason for this could be that UMMB supplementation specifically enabled the Fogera cows to ingest substantially greater amounts of hay, thereby following their motivation for increased forage consumption which was fostered by not receiving any concentrates, while the crossbred cows were still supplemented with some concentrates because of their higher milk yield. Consistent with the present results, Leng et al. (1991) reported that feeding UMMB, through its soluble nitrogen and rapidly fermentable carbohydrate supply optimizes the ruminal fermentation capacity which leads to an increased rate of fiber digestion, thereby eventually stimulating feed intake. The daily UMMB intake per cow was greater during this experiment (Table 1) as compared with (Tekeba et al., 2013). Reasons for this could be that the cows were accustomed to the blocks from the very beginning and that the reduced (crossbred) or even ceased concentrate supply (Fogera) pushed the cows to ingest more of the UMMB during late stage of lactation. UMMB supplementation to late lactating FS cows contributed 10.8 % and 25.6 % to the overall intake of ME and CP, respectively. The corresponding values for the CS cows were 10 % and 21.6 %, respectively. The supplementation of forage based diets with UMMB may improve roughage intake more than the supplementation with commonly used concentrates, as it was reported for buffalo calves (Mirza et al., 2004). Similar to dry matter intake, a significant (P ≤ 0.05) increment in crude protein and energy intake of cows was observed as a result of UMMB supplementation for both breeds. However, the relative increase in crude protein intake was greater for Fogera as compared to the crossbred cows (70 % vs. 37 %; Table 1). This may be related to the fact that the diet of late lactation Fogera cows did not contain any concentrates. The marked increase in hay intake of Fogera cows due to UMMB supplementation resulted in a greater difference in NDF intake in Fogera as compared to crossbred cows (Table 1). Protein and energy conversion ratio was rather similar between the two experiments (Tekeba et al., 2013; this experiment) for crossbred cows. In contrast to Fogera, crossbred cows consumed 37 % more CP and had a 52 % higher milk protein offtake when supplemented with UMMB, while the Fogera cows consumed 70 % more protein to produce 42 % more milk protein (Table 1). Although the difference between FN and FS was not significant, it seems reasonable that in late lactation Fogera cows, the extra protein consumed was used for body weight gain rather than for milk protein synthesis.

Table 1. Production performance and feed intake of cows of different breeds fed different diets

	Treatments				
Traits	FN	FS	CN	CS	s_e
Milk offtake (l/day)	1.40[a]	2.00[b]	3.19[c]	4.84[d]	0.543
ECM offtake (l/day)	1.60[a]	2.40[b]	3.45[c]	5.31[d]	0.609
Milk fat (g/l of milk)	45.4[c]	49.6[d]	41.5[a]	42.7[b]	1.68
Milk protein (g/l of milk)	32.5[b]	32.5[b]	30.4[a]	30.5[a]	1.30
Milk total solids (g/l of milk)	134.2[b]	139.9[c]	125.0[a]	126.1[a]	3.27
Milk fat yield (g/day)	63[a]	99[b]	132[c]	206[d]	24.6
Milk protein yield (g/day)	45.6[a]	64.6[b]	96.9[c]	147.4[d]	16.71
MEO (MJ/day)	4.70[a]	7.21[b]	9.83[c]	14.85[d]	1.736
Estimated body weight gain (g/day)	12	69	23	88	47.0
BCS	2.3[a]	2.7[b]	2.3[a]	2.6[ab]	0.21
TDMI (kg/day)	4.90[a]	6.62[b]	7.32[c]	8.52[d]	0.898
HIDM (kg/day)	4.16[a]	5.35[b]	5.68[bc]	6.18[c]	0.894
UMMBI (g/day)		528[a]		704[b]	0.1
OMI (kg/day)	4.47[a]	6.03[b]	6.66[c]	7.76[d]	0.819
CPI (g/day)	306[a]	520[b]	598[c]	820[d]	53.0
MEI (MJ/day)	32.95[a]	45.38[b]	52.93[c]	62.78[d]	5.587
NDFI (kg/day)	3.36[a]	4.31[b]	4.63[b]	5.17[c]	0.602
ADFI (kg/day)	2.08[a]	2.67[b]	2.84[b]	3.16[c]	0.377
PCR	6.91[ab]	8.32[b]	6.62[ab]	5.66[a]	1.641
ECR	7.25[b]	6.68[b]	5.81[ab]	4.20[a]	1.500

[abcd] Different superscripts indicate significant ($P \leq 0.05$) differences between means in the same row; FN = Fogera cows not-supplemented; FS = Fogera cows supplemented with UMMB; CN = Crossbred cows not-supplemented; CS = Crossbred cows supplemented with UMMB; s_e =residual standard deviation; ECM = energy corrected milk; MEO = milk energy offtake; TDMI = total dry matter intake; HIDM = hay intake on dry matter basis; UMMBI = UMMB intake; OMI = organic matter intake; CPI = crude protein intake; MEI = metabolizable energy intake; NDFI = neutral detergent fibre intake; ADFI = acid detergent fibre intake; PCR = protein conversion ratio; ECR = energy conversion ratio.

3.2. Benefit- cost analysis of UMMB supplementation

In late lactation, UMMB supplementation seems to be economically meaningful for crossbred cows only: a greater increase was observed for income from milk sales as compared to feed costs in crossbred cows than the local Fogera cows (Table 2). These results are different to those from the first experiment (Tekeba et al., 2013), where supplementation of dairy cows with UMMB was found to be economically beneficial for both breeds despite the higher nutrient and energy supply. As a result of greater persistency in daily milk offtake between mid (Tekeba et al., 2013) and late stage of lactations, the crossbred cows were more consistent in their benefit–cost ratio than the Fogera cows. Between mid and late stage of lactation, a 55 % and 5 % reduction in benefit–cost ratio was observed for Fogera and crossbred dairy cows, respectively.

Table 2. Selected economic traits of cows of different breeds fed different diets

	Treatments				
Traits	FN	FS	CN	CS	s_e
Net return (USD/day)	0.33[a]	0.44[a]	0.84[b]	1.39[c]	0.240
Net return (USD/l of milk)	0.23[a]	0.20[a]	0.25[ab]	0.29[b]	0.053
Feed cost (USD/l of milk)	0.21[b]	0.24[b]	0.19[ab]	0.15[a]	0.053

[abc] Different superscripts indicate significant (P≤0.05) differences between means in the same row; FN = Fogera cows not-supplemented; FS = Fogera cows supplemented; CN = Crossbred cows not-supplemented; CS = Crossbred cows supplemented; s_e = residual standard deviation; USD = United States Dollar (1 USD = 16 Ethiopian Birr).

4. Conclusions

From this study and from literature sources it is concluded that UMMB supplementation exerts an overall positive effect on forage and feed intake and concomitantly on productive, reproductive and economic performance of dairy cows managed under environmental conditions which are typical for the dry season in Ethiopia. However, crossbred dairy cows perform better in most traits than local Fogera at each of the dietary treatments. Supplementation of dry season diets with UMMB are likely to result in a greater response in milk yield of crossbred cows, but the opposite may occur with regards to milk fat content, while body weight changes are influenced in a similar way for both breeds. Depending on the availability of UMMB for dairy farmers, priority in supplementation should therefore be given to cows with a greater genetic potential for milk production, such as crossbred (local * exotic breeds) cows.

Acknowledgements

The authors would like to express their gratitude to all who have assisted and supported this study, particularly the OEAD-Gmbh (Austrian Agency for International Cooperation in Education and Research) and KEF (Commission for Development Studies) for funding the project and to Alemseged Gebremariam, Head of Land-O-Lakes Amhara Region, for providing the milk analyzer. The contribution of Dr. Azage Tegegne (ILRI, Addis Ababa, Ethiopia) during the planning phase of the experiment deserves great appreciation. Staff members at ALRC are gratefully acknowledged for their permanent assistance in data collection and overall support.

References

[1]. Addisu, B., 2010. Preliminary report on prediction of body weight of Fogera cattle from heart girth measurements. Andassa Livestock Research Center, North Western Ethiopia.

[2]. Addisu, B., Mengistie, T., Adebabay, K., Getinet, M., Asaminew, T., Tezera, M., Gebeyehu, G., 2010**.** Milk yield and calf growth performance of cattle under partial suckling system at Andassa Livestock Research Center, North West Ethiopia. Livestock Research for Rural Development 22, article no. 136. Retrieved May 24, 2012, from http://www.lrrd.org/lrrd22/8/bite22136.htm.

[3]. Adugna, T., 2007. Feed resources for producing export quality meat and livestock in Ethiopia. Examples from Selected Woredas in Oromia and SNNP Regional States, Ethiopia. http://www.igad-data.org/index.php

[4]. Asaminew, T., Eyassu, S., 2009. Smallholder dairy production systems and emergency of dairy cooperatives in Bahir Dar Zuria and Mecha Woredas, North-western Ethiopia. World Journal of Dairy & Food Sciences 4, 185-192.

[5]. Aynalem, H., Josh, B. K., Workneh, A., Azage, T., Avtar, S., Zelalem, Y., 2008. Genetic evaluation of Ethiopian Boran cattle and their crosses with Holstein Friesian for milk constituent traits in central Ethiopia. Journal of Cell and Animal Biology 2 (10), 171-176.

[6]. Azage, T., Berhanu, G., Hoekstra, D., 2010. Livestock input supply and service provision in Ethiopia: challenges and opportunities for market oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 20. ILRI (International Livestock Research Institute), Nairobi, Kenya. 48 p.

[7]. Bediye, S., Dejene, M., Hatawu, B., Fekadu, D., Kehaliw, A., Nesha, K., 2009. On-farm evaluation of Multi-nutrient Block (MNB) and source of soluble nitrogen as a supplement to local Kereyu lactating cows for dry season feeding in a pastoral and agro-pastoral production system of Ethiopia. In: Proceedings of the sub-regional workshop on managing East African Rangelands for better response to feed crisis, 9-12 November, 2008 Addis Ababa, Ethiopia, pp. 77-86.

[8]. Belete, A., Azage, T., Fekadu, B., Berhanu, G., 2009. Fluid milk and butter production and marketing systems in Fogera district, Amhara Region, Ethiopia. Conference on Biophysical and Socio-economic Frame Conditions for the Sustainable Management of Natural Resources. University of Hamburg, October 6-8, 2009. www.tropentag.de/2009/abstracts/full/326.pdf.

ISSN 2347-4289

[9]. Brar, P. S. and Nanda, A. S., 2007. Experiences with urea-molasses multi-nutrient blocks in Buffaloes production and reproduction in smallholder dairy farming, Punjab; India. In: Feed Supplementation Blocks. Urea-molasses multi-nutrient blocks: simple and effective feed supplement technology for ruminant agriculture: FAO Rome, pp. 59-74. ftp://ftp.fao.org/docrep/fao/010/a0242e/a0242200.pfd

[10]. CSA (Central Statistical Authority), 2008. Statistical Abstract 2007. CSA Agriculture Section, Addis Ababa, Ethiopia.

[11]. Dejene, M., Bediye, S., Kehaliw, A., Kitaw, G., Nesha, K., 2009**.** On-farm evaluation of lactating crossbred (Bos taurus **×** Bos indicus) dairy cows fed a basal diet of urea treated tef (Eragrostis tef) straw supplemented with escape protein source during the dry season in crop-livestock production system of north Shoa, Ethiopia. Livestock Research for Rural Development 21, article no. 61. Retrieved May 29, 2012, from http://www.lrrd.org/lrrd21/5/deje21061.htm

[12]. Demeke, S., Neser, F. W. C., Schoeman, S. J., Erasmus, G. J., Van Wyk, J. B., Gebrewolde, A., 2000. Crossbreeding Holstein Friesian with Ethiopian Boran cattle in a tropical highland environment: preliminary estimates of additive and heterotic effects on milk production traits. South African Journal of Animal Science 30 (1), 32-33.

[13]. ELDMPS (Ethiopia Livestock Development Master Plan Study), 2007. Livestock Development Master Plan Study, Volume 1-Dairy. Phase 1 Report- Data collection and Analysis. Government of Ethiopia, Ministry of Agriculture and Rural Development. http://www.igad-data.org/index.php

[14]. Fekadu, D., Bediye, S. and Sileshi, Z., 2010. Characterizing and predicting chemical composition and in vitro digestibility of crop residue using near infrared reflectance spectroscopy (NIRS). Livestock Research for Rural Development 22, article no. 29. Retrieved July 13, 2012, from http://www.lrrd.org/lrrd22/2/feka22029.htm

[15]. GTP (Growth and Transformation Plan), 2010. The Federal Democratic Republic of Ethiopia Growth and Transformation Plan 2010/11-2014/15 Draft. Ministry of Finance and Economic Development, Addis Ababa Ethiopia, pp. 16-18. http://www.ethiopians.com/Ethiopia_GTP_2015.pdf

[16]. Kabir, F., Islam, M. R., 2009. Comparative study on productive and reproductive performance of local and different crossbred dairy cows at Daulatpur, Khulna in Bangladesh. Bangladesh Research Publications Journal 3 (2), 909-914.

[17]. Khan, M. A. S., Chowdhury, M. A. R., Akbar, M. A., Shamsuddin, M., 2007. Urea molasses multi-nutrient blocks technology-Bangladesh experiences. In: Feed Supplementation Blocks. Urea-molasses multi-nutrient blocks: simple and effective feed supplement technology for ruminant agriculture, FAO Rome, pp. 75-88. ftp://ftp.fao.org/docrep/fao/010/a0242e/a0242e00.pdf

[18]. Leng, R. A., Preston, T. R., Sansoucy, R., George Kunju, P. J., 1991. Multi-nutrient block as a strategic supplement for ruminants. In: Harnessing biotechnology to Animal production and Health. FAO Corporate Document Repository-67-1991/2. http://www.fao.org/docrep/003/w7448e/w7448e00.htm

[19]. MAFF, 1984. Energy Allowances and Feeding Systems for Ruminants. Second edition. Reference Book 433, Her Majesty's Stationary Office, London. 85 p.

[20]. Mendieta-Aracia, B., Spörndly, R., Reyes-Sanchez, N., Spörndly, E., 2011. Moringa (Moringa oleifera) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in tropical areas. Livestock Science 137, 10-17.

[21]. Mesfin, R., Getachew, A., 2007. Evaluation of grazing regimes on milk composition of Borana and Boran-Friesian crossbred dairy cattle at Holetta research center, Ethiopia. Livestock Research for Rural Development 19, article no. 179. Retrieved May 18, 2012, from http://www.lrrd.org/lrrd19/12/mesf19179.htm

[22]. Mirza, I. H., Anjum, M. I., Khan, A. G., Azim, A., 2004. Comparative evaluation of cotton seed meal and sunflower seed meal in urea molasses blocks versus commercial concentrate as supplement to basal ration of wheat straw with stall-fed Buffalo calves. Asian-australasian journal of animal science 17, 193-198.

[23]. Misra, A. K., Subba Reddy, G., Ramakrishna, Y. S., 2006**.** Participatory on-farm evaluation of urea molasses mineral block as a supplement to crossbred cows for dry season feeding in rain-fed agro-ecosystem of India. Livestock Research for Rural Development 18, Article #24. Retrieved May 12, 2012, from http://www.lrrd.org/lrrd18/2/misr18024.htm

[24]. Moran, J., 2005. Nutrient requirements of dairy cows. Tropical dairy farming: feeding management for small holder dairy farmers in the humid tropics. Landlinks press, pp. 1-9.

[25]. Nyambati, E. M., Sollenberger, L. E., Kunkle, W. E., 2003. Feed intake and lactation performance of dairy cows offered Napier grass supplemented with legume hay. Livestock Production Science 83, 179-189.

[26]. Phung, L. D., 2009**.** Genotype by environment interaction: a case study of productive and

reproductive performance of Yellow local and F1 (Red Sindhi x Yellow local) cattle in two production zones in Quang Ngai Vietnam. Livestock Research for Rural Development. Volume 21, Article #17. Retrieved April 21, 2012, from http://www.lrrd.org/lrrd21/2/phun21017.htm

[27]. RHHSEBS (Rural Households Socio Economic Baseline Survey), 1998. Rural Households Socio Economic Baseline Survey of 56 woredas in the Amhara Region. Livestock Production. Vol. VIII.

[28]. Rodenburg, J., 2000. Body Condition Scoring of Dairy cattle. Ministry of Agriculture, Food and Rural Affairs, Ontario, Canada. http://www.omafra.gov.on.ca/english/livestock/dairy/facts/00-109.htm

[29]. Sahoo, B., Vishwanath, C., Bhushan, K. J., Agarwal, A., 2009. Effect of Urea Molasses Mineral Block Supplementation on milk production of cows (Bos indicus) in mid Hills of Uttarakhand. Animal Nutrition and Feed Technology 9, 171-178.

[30]. SAS (Statistical Analysis System), 2009. SAS/STAT User's Guide, Version 9.2. Cary, NC, USA.

[31]. Seyoum, B. and Feyissa, F., 2006. The status of Animal feeds and nutrition in the west shewa zone of Oromiya, Ethiopia. Holetta Agricultural Research Center, Addis Ababa, Ethiopia, pp. 27-49.

[32]. Sinclair, L. A., Hart, K. J., Wilkinson, R. G., Huntington, J. A., 2009. Effects of inclusion of whole-crop pea silages differing in their tannin content on the performances of dairy cows fed high or low protein concentrations. Livestock Science 124, 306-313.

[33]. Sudhaker, K., Reddy, G. V. K., Krishina, N., 2002. Effect of supplementation of urea- molasses mineral block on quantity and quality of milk production in Murrah buffaloes. Indian Journal of Animal Nutrition 19 (4), 301-305.

[34]. Tekeba E., Wurzinger M., Baldinger L., Zollitsch W. J., 2013. Effects of dietary supplementation with urea molasses multi-nutrient block on performance of mid lactating local Ethiopian and crossbred dairy cows. Livestock Research for Rural Development 25 (6) 2013.

[35]. Teshome, D., 2009. On-farm evaluation of urea treated rice straw and rice bran supplementation on fed intake, milk yield and composition of Fogera cows, north western Ethiopia. MSc. Thesis, Bahir Dar University, Bahir Dar, Ethiopia.

[36]. Tilahun, A., Solomon, M., Ralph, R., 2005. Identification of livestock feed production in Ethiopian highlands: Potential and Experiences of the African Highlands Initiative; Presented at the 19th Ethiopian Veterinary Association (EVA) Annual conference, 8 June 2005, Addis Ababa, Ethiopia, pp. 3-9.

[37]. Tyrrell, H. F., Reid, J. T., 1965 (1). Prediction of the energy value of cow's milk. In: Effects of dairy cow genotype with two planes of nutrition on energy partitioning between milk and body tissue. Journal of Dairy Science 89, 1031-1042.

[38]. Tyrrell, H. F., Reid, J. T., 1965 (2). Prediction of the energy value of cow's milk. In: DHI GLOSSARY (2011). Dairy Records Management Systems (DRMS). 31 p. http://www.drms.org/PDF/materials/glossary.pdf

[39]. Upreti, C. R., Shrestha, B. K., Ghimire, B., 2010. Effect of UMMB Supplementation during winter on the milk production and its composition and infertility in dairy cattle in hill management production system. Nepal Journal of Science and Technology 11, 71-78. http://www.nepjol.info/index.php/NJST/article/view/4126

[40]. Wiktorsson, H., 1979. General plane of nutrition for dairy cows. In: Effect of feeding level on milk production, body weight change, feed conversion and postpartum oestrus of crossbred lactating cows in tropical conditions. Livestock Production Science 77, 331-338.

Table 3. Chemical composition of feed ingredients (percent DM basis)

Feedstuff	DM %	Ash %	OM %	NDF %	ADF %	Lignin %	CP %	DOMD %	ME MJ/kg
Concentrate	90.3	9.98	90.0	28.5	13.4	03.78	22.5	78.1	11.7
UMMB	91.8	8.43	91.6	29.7	16.9	06.40	27.4	64.1	09.6
Nug cake	92.3	8.72	91.3	35.8	29.6	11.30	34.9	64.5	09.7
Hay	91.5	8.78	91.2	66.8	41.9	04.45	05.8	41.3	06.2
Napier grass	18	9.45	90.6	78.6	45.5	08.37	08.7	64.5	09.7

DM = dry matter; OM = organic matter; NDF = neutral detergent fibre; ADF = acid detergent fibre; CP = crude protein; DOMD = digestible organic matter in dry matter; ME = metabolisable energy