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Original Article

Performance of Lactating Desert Goats Fed On Molasses and Crop Residues Blocks in North Kordofan, Sudan

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ABSTRACT

This study was conducted in Sheikan locality (Attitudes 11^0 15', longitudes 27^0 32'), North Kordofan state during March 8th to April 11, 2009 with the objective of studying effects of feeding molasses blocks on milk production and live body weight changes of lactating Desert goats and their kids. Twenty four goats at different parity and weighing 29.8 kg ± 0.39 kgs with single kids were divided into four similar groups of six animals. The first group was left on the natural dry season grazing (NG); the second on NG supplemented with molasses blocks formulated using groundnut haulms and the third group were offered molasses block containing sesame stalks (M+SS) and the last group was left on molasses blocks formulated of equal proportions of groundnut haulms and sesame stalks (M+H+SS). The supplements were offered in the morning and were consumed completely before offering the basal diet of natural grazing while water was provided unrestrictedly. The results indicated that voluntary dry matter intake was significantly (P<0.01) higher in goats that were fed NG supplemented with M+H followed by those supplemented with M+SS and M+H+SS while those on the NG consumed significantly (P<010) smaller amounts of feed. Milk production of the goats that were on supplementary feeding increased significantly (P <0.01) compared to those on M+H followed by the group on (M+H+SS) and lastly those on M+SS. Live bodyweights observations have shown that the group on molasses blocks gained Significantly (P<0.01) higher weight and were heavier at the end of the experimental period for those which were fed M+SS+H followed by those on M+SS and M+H which were similar. The goats on NG only lost 4.5kg weight during the experimentation period. Weight gain of kids was higher in those whose dams were supplemented with greater weight gains attained when dams were fed

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NG supplemented with M+H followed by those on M+H and finally those on NG only. The study concluded that goats on dry season NG supplemented with molasses block and crops residues could increase milk production and live body weight gains for dose and their kids and it was recommended that studies be conducted to evaluate effects of feeding goats for other purposes and investigate reasons for superiority of groundnut haulm over sesame stalk in enhancing weight gains and milk production
Keywords: Goats Nutrition, Molasses Block. Milk Production.

INTRODUCTION

Sudan owns large population of livestock species. This wealth is of significant contribution to the national and regional economies. It is the main source of livelihood to the rural family income derived from economic value of purchased animals and animal products such as milk, meat and by products represented by skins and hides (EL Hag *et al*., 2001).

Goats play an important role in all agricultural systems in Sudan and they have special place in the economies of the study area. They provide meat, milk and are source of cash from sales of live animals and meat. Feeding goats in Sudan is constrained by feed scarcity especially during the dry season, low quality of roughages available for their feed and lack of proper feeding strategies recommended for the small scale producers (Jadalla *et al*., 2012).

The reasons that favor goats' raising arid areas in Sudan are their capability to supply subsistence products for consumption like meat and milk and their use for other special social and religious purposes, as the means of savings yielding high returns while requiring low investment and imposing low financial risk. They represent a source of immediate liquidity for the producers that complement other production activities. Goats under the traditional farming systems of Sudan in general and North Kordofan in particular are raised on open rangelands (Gallad *et al.,* 1988). The most common management system employed is to allow goats to graze freely during the day; usually attended by small boys and girls and to have them into pens at night. Goats' productivity decreases during the dry season because of feed shortage and low quality of the natural grazing that goats depend on at that time. To sustain productivity and high reproductive performance of goats, low cost, locally available and high nutritive feed sources are needed. Crop residues are abundant in the rural areas though they are of low quality. To improve their utilization in feeding livestock and goats in particular they must be supplemented with protein and energy sources. Molasses are produced as by-product from sugar industry in Sudan and can be source of energy and minerals. Seed cakes are also available and small amounts added to crop residues together with molasses can provide a sufficient ration for maintenance and production during the dry seasons (Al Khider *et al*., 1992). Such types of rations have not been tried in rural North Kordofan in feeding goats

The Objective of the Study

The overall objective of this study was to research towards development of sustainable livestock feeding systems based on locally and available low cost ingredients of feed sources for the growing livestock population of the country. The improved utilization of the available feed resources is also essential.

In particular, the study aimed at studying the effects of supplementation of does on natural grazing with molasses blocks on voluntary dry matter intake. It was also intended to study the effects of the feeding pattern of does on natural grazing with molasses on nutrients digestibility coefficients, total digestible nutrients and energy intake by goats. Studying the effects of this supplementation method of does on milk production and weight gain of does and their kids.

MATERIALS AND METHODS

The study area

This study was conducted in Elobeid, Sheikan locality (longitudes 26^0 56' and 32^0 25' E and latitudes 12^0 00' and 16^0 35' N), North Kordofan, Sudan. The city is located at 1900 feet above sea level. Precipitation increases from 250 mm in the north to reach 300 mm in Elobeid and 350 mm in the south and this rainfall continues from May to September with peak in August (Osman, 2006). Temperatures are at highest degree during April to June; of up to 44º Celsius and the minimum degree of 10° C was recorded during December, January and February. There are some trees forming the type of vegetation in this region, such as *Balanites aegyptiaca*, *Albizzia amara* , *Tamarindus indica*and many others (Al Awad , 2009).The animals raised are Desert goats, sheep, cattle and camels. The main feed source is the natural grazing with crop residues and imported rations.

The experimental feed and rations

Groundnut haulms were obtained from farmers at the experimental site in Abu owroug village 5 kilometers south east of El-obeid city. Large quantities are produced every year as a result of harvesting the crop in all parts of Kordofan and used for feeding animals during dry seasons. This crop residue is good quality roughage with crude protein reach over 8% and has a high market value for its conventional use in feeding different animal species and for different purposes.

Sesame stalks were secured also from farmers in the village. The stalks are not usually used for feeding animals for its low nutritive value and the roughage is unpalatable if offered alone. It was treated and used in formulation of molasses blocks in dairy rations (El Hag *et al*.,2001).Sesame stalks provide roughage of fibrous nature and is low in its crude protein content rich in calcium and phosphorus. It was rather cheaper compared to groundnut haulms.

Experimental rations used were as follows: Ration I was prepared for the first group and was the natural dry season grazing (NG); the second ration was the NG supplemented with molasses blocks formulated using groundnut haulms (M+GNH), the third group were offered a ration of molasses block containing sesame stalks (M+SS) and the last group was left on molasses blocks formulated of equal proportions of groundnut haulms and sesame stalks (M+H+SS).Percent ingredients used in ration formulation are presented in table (1).

Table (1) Ingredients used in formulation of molasses block prepared for the experimental goats

Feed	Rations			
	I	II	III	IV
Molasses	-	50	50	50
Groundnut Hay	-	32	-	16
Groundnut Seed Cake	-	10	10	10
Sorghum Straw	-	-	32	16
Salt	-	2	2	2
Urea	-	3	3	3
Limestone	-	3	3	3
Natural grazing	100	-	-	-
Total	100	100	100	100

The experimental animals

Twenty four lactating Desert does were used in this experiment. They were 1-4 years old and weighing 29.8 kg ± 0.39 kg. All goats were at their early lactation period and each had one kid or twins (29 in total). The goats were variable in size ranging from medium to large with

different colors. They were divided into four equal groups according to age, initial live weight and number of kids. Those four goat groups were randomly assigned to the four experimental rations using a randomized complete block design (Steel and Torrie, 1980). Before the start of the experiment all goats were kept for 7 days as an adaption period during which all animals were treated with Ivomec^{R} at a rate of 0.5 cc injections per head applied subcutaneously against external and internal parasites. All goats were ear tagged and tethered individually at suitable distance from each other. The kids were kept in a separate enclosure and allowed to suckle their mothers for a short period in the morning and in the evening just at the time of milking.

Body weight measurements

The lactating goats and their kids were weighed at the beginning of the trial and weekly thereafter to the end of the experimental period using spring balance (50 kg capacity). Goats weighing was done early morning following overnight fast. The kids were weighed before being allowed to suckle their dams. Monthly body length and heart girth measurements were taken for the lactating goats and their kids using a measuring tape. The trial lasted four 90 days extending from December 2009 to March 2010.

Feed and water intake

The supplemental feed for each goat group was offered at 8:00 am every morning. The amount of the basal feed consumed was determined by subtracting the weight of feed offered the day before from the animals' refusals. The supplements were consumed completely before giving the basal diet. Daily feed samples were collected for each diet and retained for subsequent laboratory analysis. Water intake was also measured after the does had water using a graduated measuring cylinder.

Milk samples

The does were milked once in the morning and again in the evening and milk was measured using a graduated measuring cylinder.

Milk samples were collected at the beginning of the trials and every two weeks thereafter. Samples were immediately taken to the laboratory and subjected to chemical analysis according to methods described below.

Analytical Procedures

Feed analysis

Feed samples collected from each ration were composted, ground and air dried for proximate chemical composition. dry matter DM, organic matter OM, ash, crude protein CP m, crude fiber CF m, ether extract EE and nitrogen free extract NFE were determined according to the analytical methods of the AO AC (2000). Samples from each ration were analyzed for in vitro dry matter digestibility IVDMD according to Tilley and Terrie (1963). Digestible energy DE was calculated using Rettehouse *et al.,* (1971) formula:

Mcal DE/kg DM= .039(OMD-0.1 where DM= Dry Matter, OMD= Organic matter digestibility.

Digestible crude protein was calculated according to Knight *et al*., (1966) formula:

DCP(g/kgDM)=0.85 CP(g/kgDM)-2.1

Where DCP=digestible crude protein, CP = crude protein, DM = dry matter.

Milk analysis

Milk samples collected every 15 days were analyzed for milk fat (AOAC, 2000) protein and total solids (Willit,1951), ash (Baily,1937) and lactose according (AOAC,1990).

Blood Sample

Blood Samples were collected at the beginning and at the end of the experiment and samples were analyzed for packed cell volume (PCV), Hemoglobin (Hb), Blood glucose and total protein and for Ca and P contents. PCV was determined using microhaematocrit method (Thomas, 1981). Haemogolobin was measured by spectrophotometer (Gorby *et al.,* 1954). Glucose was measured according to GOD-PAP enzymatic method (Tinder. 1969). Total protein was determined by burette method (AOAC, 2000). Atomic absorption spectrophotometer method was used for determination of organic phosphorus and calcium (Henry, 1974).

Statistical analysis

Data for the proximate chemical composition of the four rations were analyzed as completely randomized block design. Animal performance data (body weight, body measurements, feed and water intake, milk yield and kids weight and body measurements) were analyzed as completely randomized block design. Milk composition and blood profile were analyzed as a randomized complete block design. Duncan multiple range test was used for means separation (Steele and torrie,1980). Simple correlation coefficients were computed among different animal performance parameters (Steele and torrie,1980). Mstat–C software program was used for the statistical analyses (Freed,1992).

RESULTS AND DISCUSSION

The ingredients used in formulation of molasses blocks used in this study are presented in table (1). The ingredients used ad their proportions are similar to those used by Al Khider *et al*., (1992). Blocks were immediately consumed by the does though the goats had no previous experience in molasses rations. McDonalds *et al*. (2010) had observed having ruminants abstain from molasses consumption when offered for the first time.

Table (2): Chemical composition of the ingredients used in Molasses block rations prepared for feed does in Elobeid

Feed	DM	OM	CP	CF	EE	NFE	ASH
Molasses	75.36	63.12	3.52	0	1.5	58.1	12.24
Groundnut Hay	97.0	90.68	5.67	30.36			6.32
Groundnut Seed Cake	65.4	56.15	18.5	13.62	-		9.25
Sesame straw	93.5	77.75	6.33	36.42	7.96	16.07	15.75
Salt	-	-	-	-	-	-	-
Urea	-	-	-	-	-	-	-
Limestone	-	-	-	-	-	-	-
Natural grazing	96.73	83.49	2.42	31.24	0.9	47.64	14.54
Total	-	-	-	-	-	-	-

Daily feed intake is presented in table (2). Does on molasses blocks formulated using groundnut haulms, sesame stalk or the two residues together consumed significantly ($P<0.010$) greater amounts of dry matter (820g/head / day) than those on the natural grazing alone (550g/head/day). The increased daily feed intake for the three groups on molasses block is attributed to better digestibility of nutrients upon supplementation with energy (molasses) and proteins (groundnut seed cake). The nutrients mentioned improved rumen ecosystem and increased cellulytic microflora that enhanced movement of the digesta from the gut due to increased digestibility and absorption of nutrients. Similar results were reported by Preston and Margueittio (1992). Who reported higher feed intake of lactating goats upon supplementation with molasses blocks compared to those on low quality roughage alone.

Konanadreas and Anderson (1982) also found similar results and concluded that the quantity and quality of feed offered could determine dry matter intake. Contrary to this McDonald *et al.*, (1995) reported that feed intake of lactating goats could be affected by lactation period and pregnancy irrespective of nutritive value of feed presented.

Does on their third parity had the highest (P<0.01) feed intake compared to those at first or second parity for the same type of feed. The ration parity interaction has indicated that feed intake was significantly (P<0,01) highest feed intake when offered ration IV (molasses blocks formulated using 50:50 groundnut haulms: sesame stalks) compared to the other three rations. All parity groups consumed significantly (P>0.05) lower amounts of feed when left on the natural grazing alone. The results reported in this study are in agreement with that reported by Chopping *et al.,* (1976) who fed lactating ewes poor quality roughage fortified with molasses urea and observed increased intake (Table 3,4,5).

Effects of feeding does with molasses blocks on milk production

Supplementation of does with molasses blocks significantly increased (P <0.01) milk production compared with natural grazing alone irrespective of their parity. That could be attributed with to increased feed intake and better digestibility coefficients. Similar results were reported by Al Khider *et al.*, (1992) who showed that molasses blocks fed to does increased milk yield. El Gallad *et al.,* (1988) found that dietary energy did not improve total lactation performance in does (Table 6).

Table (3): Chemical composition of molasses block used in feeding the does

Nutrients	Rations			
	I	II	III	IV
DM	96.73	98.86	94.56	97.55
OM	83.49	82.05	82.05	83.06
CF	31.24	11.01	12.62	9.52
CP	2.41	8.87	9.43	8.78
EE	0.9	21.68	21.68	23.27
NFE	47.64	40.45	42.45	32.65
ASH	14.54	16.81	12.46	14.49

Table (4): Overall performance of Does and kids as affected by type or ration

Parameters	Treatments				
	I	II	III	IV	SE
NO of animals	6	6	6	6	-
Experimental period (weeks)	6	6	6	6	-
Initial weight of does	27.250	28..000	26.500	27.500	
Final weight of does	32.700	33.500	31.200	33.500	
Live weight gain of does(g/day)	139	130	112	143	NS
Initial weight of kids	11.000	12.500	11.500	12.300	NS
Final weight of kids	16.000	16.300	16.500	16.700	
Live weight gain of kids g/day	119	90	119	104	
Daily feed intake	551	822	821	817	
Feed conversion ratio kg DM:WG	1.01	1.03	0.93	1.36	
Milk production(Liter/day)	1.380	1.650	1.500	1.490	

Effects of feeding does with molasses blocks on live body weight change

Does on natural grazing and supplemented with molasses block gained significantly ($P<0.01$) greater daily weight than those left on the natural grazing alone. Type of residue used had no effect on live weight gain attained. The improved weight gain upon supplementation with molasses block could be attributed to increased feed intake, better digestibility of nutrients in addition to minerals and vitamins taken from molasses and seed cakes used in blocks formulation. Preston and Leng (1987) have shown that ruminants including goats could perform better when their poor roughage were supplemented with molasses and seed cake where molasses could supply soluble sugars for microbial growth which are responsible for fiber digestion making optimal utilization of the low quality roughage. Nitrogen source is essential for the microorganisms to grow (Table 7).

Table (5): Total, weekly and daily body weight change of Desert goat kids as affected by type of molasses blocks fed to the does

Rations	N=	Total body weight	Weekly LW	Daily LW
I	6	12.93	2.16	0.31
II	6	14.86	2.48	0.35
III	6	13.11	2.19	0.31
IV	6	13.96	2.33	0.33
SE	0.266			
Parity				
1st	8	10.39	1.73	0.25
2nd	8	15.92	2.65	0.38
3rd	8	15.85	2.48	0.35
SE	0.326			
Ration I and parity interaction				
1st parity x ration	2	6.72	1.12	0.16
2nd parity x ration	2	16.85	2.81	0.40
3rd parity x ration	2	15.24	2.45	0.36
Ration II parity interaction				
1st parity x ration	2	8.88	1.48	0.21
2nd parity x ration	2	17.79	2.97	0.42
3rd parity x ration	2	18.58	3.10	0.44
Ration III parity interaction				
1st parity x ration	2	10.49	1.75	0.25
2nd parity x ration	2	16.56	2.76	0.39
3rd parity x ration	2	12.29	2.05	0.29
Ration IV parity interaction				
1st parity x ration	2	15.48	2.58	0.38
2nd parity x ration	2	12.48	2.08	0.30
3rd parity x ration	2	13.93	2.32	0.33
SE	0.652			

Table (6): Milk production of Desert does as affected by type of molasses blocks consumed

Rations	N	Total milk production	weekly	Daily
I	6	8.28	1.38	0.19
II	6	9.90	1.65	0.24
III	6	9.00	1.50	0.21
IV	6	8.94	1.44	0.21
SE	58.52			
Parity				
1st	8	6.72	1.12	0.16
2nd	8	9.90	1.65	0.24
3rd	8	10.32	1.72	0.25
SE	71.67			
Ration _Parity interaction				
Ration I x parity 1	2	7.62	1.27	0.18
Ration 1 x parity 2	2	8.52	1.42	0.20
Ration I x Parity 3	2	8.82	1.47	0.21
Ration II x parity 1	2	9.24	1.54	0.22
Ration II x parity 2	2	10.62	1.77	0.25
Ration II x parity 3	2	9.96	1.66	0.24
Ration III x parity 1	2	5.34	0.89	0.13
Ration III x parity 2	2	10.86	1.81	0.26
Ration III x parity 3	2	10.74	1.97	0.26
Ration IV parity 1	2	5.52	0.92	0.13
Ration IV parity 2	2	9.54	1.59	0.23
Ration IV parity 3	2	11.82	1.97	0.28
SE	143.34			

Table (7): Body Weight change of does as affected by type of molasses blocks offered

Rations	N	T0tal body weight	Weekly gain	Daily gain
I	6	26	4.40	0.63
II	6	31	5.20	0.74
III	6	22	4.50	0.64
IV	6	29	4.90	0.70
SE	0.39			
Parity				
1st	8	24	4.08	0.58
2nd	8	30	5.01	0.72
3rd	8	33	5.60	0.80
SE	0.48			
Ration _Parity interaction				
Ration I x parity 1	2	21.16	3.53	0.50
Ration 1 x parity 2	2	30.17	5.05	0.72
Ration I x Parity 3	2	31.08	5.18	0.88
Ration II x parity 1	2	24.35	4.06	0.58
Ration II x parity 2	2	32.80	5.47	0.78
Ration II x parity 3	2	36.80	4.58	0.66
Ration III x parity 1	2	25.90	4.32	0.62
Ration III x parity 2	2	28.08	4.68	0.67
Ration III x parity 3	2	27.49	4.58	0.65
Ration IV parity 1	2	26.46	4.41	0.63
Ration IV parity 2	2	29.38	4.90	0.70
Ration IV parity 3	2	33.69	4.62	0.80

Conclusions

Supplementation of the Desert does that were dependent on the low quality roughage (natural grazing) deficient in protein energy, minerals and protein with molasses blocks prepared from agro-industrial byproducts and crop residues such as sesame stalks, improved feed intake, nutrient digestibility and overall performance of does in term of milk production and live weight gain. Kids' weight was also better when their dams were supplemented with molasses blocks.

Recommendations

During the long dry season, livestock are kept on natural grazing deficient in nutrients needed for maintenance and production. High price of ingredients used in rations preparation forced small traditional small ruminants' producers to adopt techniques for restricting kidding to coincide with short rainy season. Simple innovations were necessary to sustain livestock production under such conditions. Using low quality low cost ingredients were tried and among these molasses and crop residues were evaluated and found suitable. Hence small producers can be assisted by providing molasses and other low cost ingredients to feed their goats for milk production during the long dry season. Other sources such as browse trees biomass and insect meals are recommended for development of sustainable feeding strategies based on local resources.

References

AOAC, Official Methods of Analysis of the Association of Official Analytical Chemists (1984) Sidney Williams *Published By Ass. of Offic. Analyt. Chemi, 1984*

Bailly, Street, R.B. (1937). Some observation on methods of shining cereal Products. *Cereal chemistry, 14:120-128*.

Chopping, G. D. , Deans, H. D. , Sibbick, R. , Thurbon, P. N. and Stokoe, J. (1976).Milk production from irrigated nitrogen fertilized pangola grass. *Proc. Aust. Soc. Anim. Prod., 11: 481-484*

Cook, R. H. and Fadlala, B. (1987). Seasonal variation of plasma phosphorus levels of transhumant sheep in Kordofan, Sudan. *Trop. Anim. Hlth. Prod.,19:57-62.*

El Gallad ,T. T Gihad , E A., Allam , S. M. and Badawwy, T.M. (1988). Effects of energy and roughage ration on the lactation of Egyptian Nubian goats. *Small ruminant Research1 (4): 237-341*

El Hag , F.M.; Fadalla, B. and Mukhtar, H. K. (2001). Some Production Characteristics of Sudan Desert sheep under range condition in North Kordofan, Sudan. *Tropical Anim. Health and Production. 33: 9-239*

El Hag, F.M, Fadalla, B. and Mukhtar, H. K. (2001). Some Production Characteristics of Sudan Desert sheep under range condition in North Kordofan, Sudan, *tropical Anim Health and Production. 33: 9-239.*

El-Khider, J.A., Babiker, S.A., and Shafie, S.A., (1998). Comparative feedlot performance and carcass characteristics of Sudanese Desert sheep and goats. *Small Ruminant Research*, 30,147-151.

Fischer, S. D. (1990). Micro-computer Statistical Program (MSTATC-C) Statistical Package. *Michigan State University, USA*

Freed, R D., (1992). Computer Use for Farming Systems Research. FSR Workshop, Sept. 1992 *Plant and Soil Sciences Michigan State University.*

Grosby P, Mun J. P. Furth W.G. (1954). Cited in: V. S. Armed (194). Photometry and spectrophotometry. *Medical Publishers Inc., Chicago, USA.693 p.Henry, 1974*

Jadalla ,J. B.; Ismail, I. A. and Mekki, D. M.(2012). Effects of Dietary Protein Level on Milk Yield, Composition and some Hematological Parameters in Desert goats of North Kordofan, Sudan *J. Anim. Prod. Adv., 2012, 2(9):379-388*

Konanadreas,P. A. and Anderson, F. A.(1982). Cattle herd dynamics: an integrated and stochastic model for evaluating alternatives, *ILCA Research Report No. 2 ILCA Addis Abba Ethiopia*

McDonald, P.; Edwards, R. A., Greenhalgh, J. F. D.; Morgan, C.A.; Sinclair, L. A., and Wilkinson, R., G. (2010). Animal Nutrition seventh edition *Longman Scientific and Technical, Prentice Hall, New Jersey, USA*

Preston, T. R. and Leng, R. A.,(1987). Matching ruminant production systems with available resources in the tropics and subtropics. Penambul Books: Armidale, N.S.W.

Preston, T.R. and Murgueitio, E.(1987). Tree and shrub legumes as protein sources for livestock. In: Forage legumes and other local protein sources as substitutes for imported protein meals (Editor: D. Walmsley).*CTA,Wageningen and CARDI , Trinidad pp. 94-104.*

Reittenhouse, L.R.; Streeter C.L. and Clantion, D.C. (1971).Estimation of Digestion energy from dry and organic matter in diets of grazing Cattle, *Journal of Range Management 24:73-75.*

Steel, R.G. and Torrie, J.H. (1980). Principles and Procedures of Statistics *McGraw Hill Book CompanyInc.New York.*

Thompson, P.G. (1980). Goat breeding in Fiji. *South Pacific Bullentin 15, 28-30.*

Tilley, J. M. A. and Terrie, R. A. (1980) A two stage technique for the in vitro digestion of forage crops *Current Contents/Agricultural Biology and Environmental Sciences 15:16*

Tinder, P. (1969).Annual Clinical Biochemistry Bulletin No. 24

Van Soest, P. J. (1982). Nutritional Ecology of the Ruminant, *O & B Books, Inc Corvallis, Oregon USA. pp. 76-78.*

Willit, C. O., (1951).Methods for determination of moisture through oven drying *Analytical chemistry, 23:1058-1062*