Pakistan J. Zool., vol. 47(4), pp. 1097-1102, 2015.

Comparative Efficacy of Urea and Slow-Release Non-Protein Nitrogen on Performance of Nili-Ravi Buffalo Calves

Muhammad Irfan Khan,[1]* Saeed Ahmed,[1] Abdur Rahman,[1] Fayyaz Ahmad,[4] Anjum Khalique,[1] Nisar Ahmad,[1] Zakia Qadir,[1] Sajid Umar,[3] Sami Ullah[1] and Burhan E. Azam[4]

[1]Department of Animal Nutrition, University of Veterinary and Animal Science, Lahore
[2]Department of Livestock Production, University of Veterinary and Animal Science, Lahore
[3]Department of Pathobiology, Arid Agriculture University, Rawalpindi
[4]Buffalo Research Institute Pattoki, Kasur

Abstract.- Shortage of feed for animals is becoming a serious problem. In the wake of scarcity of adequate feed, the buffalo calves are being fed feed residues or low protein feeds which adversely affect the meat quality. Feed quality can be improved by adding NPN sources. The present study was conducted to evaluate the efficacy of urea and slow release non protein nitrogen on the performance of Nili-Ravi buffalo calves. Three groups (A, B, C) of buffalo calves, each containing 5 animals of Nili-Ravi breed fed 1% urea and 1% NPN (Optigen), were used. Feed intake, growth rate, feed efficiency, blood glucose and blood urea nitrogen of male buffalo calves. Maximum feed intake and significant weight gain was observed in group B fed 1% urea ($P<0.05$) compared with other groups. The blood urea nitrogen of calves in group B was also higher than other groups. No difference was observed in blood glucose and blood urea nitrogen level of all groups ($P>0.05$). It was concluded that addition of 1% urea in the feed of calves can improve feed intake, feed conversion ratio and daily weight gain more efficiently than other NPN sources (optigen). Moreover, use of urea is more economical for fattening of Nili Ravi buffalo calves.

Keyword: Urea feeding, feed intake, performance, buffalo calves.

INTRODUCTION

Livestock contribute 55.4% to agriculture and 11.9% to national GDP of Pakistan. Main products of livestock are milk and meat. In 2013 the meat production has increased from 3,379,000 tons to 3,531,000 tons (beef 1,829,000 to 1,887,000) in Pakistan while per capita meat consumption is 21 kg/annum which is very little compared with developed countries (Anonymous, 2014). Pakistan population is increasing and ultimately meat demand is also increasing. Fortunately Pakistan is the home tract of finest natural breeds of livestock. Nili Ravi buffalo breed is one of them. Dairy animal can be used for meat production especially male calves and dairy bulls that are no more needed for breeding can be utilize for beef purpose. Fattening is one of the major concerns in the livestock sector. For fattening economics should be considered to make it profitable. The use of low price feed with high nutritive value is more important for this purpose. In Pakistan the animal feed comprises crop residue, mainly wheat straw and stovers etc. These crop residues are poor in palatability, digestibility and nutrients (protein, minerals and vitamins). Urea increases the nitrogen availability which in turn improves the protein content (Khan *et al.,* 1999; Rath *et al*., 2001). It is the need of the time to explore our existing livestock feed resources to fulfill the protein requirements of animals. This target can be achieved by optimizing the forage and fodder production. In Pakistan the main focus is cultivation of cash crops instead of fodder crops, less fodder crop cultivation and low quality forages are the main factors that badly affect the animal production. In future due to increasing human population animals will have to rely on forages because there will be direct competition between humans and animals for grains. To overcome the possible shortage we must use the cheap and economical products in ration to fulfill the nutritional requirement of animals. In the tropical areas low quality forages and high priced protein sources such as soybean and other oil cakes are the main constraints in the livestock feeding. This protein deficiency can be fulfilled by the addition of

* Corresponding author: irfanmayo90@gmail.com
0030-9923/2015/0004-1097 $ 8.00/0

non-protein nitrogen source (urea) which is hydrolyzed into ammonia in the rumen, and can be utilized by the ruminal microbes to synthesize protein.

The most common non-protein nitrogen (NPN) source used in ruminant feeding is urea, due to its low cost; thus, when prices of protein feeds escalate (*i.e.*, soybean meal), it is economical to use urea as a nitrogen supplement in ruminant diets. Using the protein equivalent of 287%, incorporation of one unit of urea in a diet can replace five units of soybean meal. However, the final decision is not just a matter of a mathematical substitution. The amount of NPN that can be used is limited due to the rapid hydrolysis of this N source, which causes accumulation and escape of ammonia from the rumen (Satter and Roffler, 1975). The use of NPN (urea) in ration is limited because it is readily converted into NH_3. This faster release causes over production of ammonia which is absorbed by rumen wall and cause toxicity. To avoid this faster release of ammonia and optimizing the nitrogen availability, various methods for the use of NPN products as in form of multi nutritional blocks and in the form of urea compound as optigen are in practice. Optigen is a concentrated NPN source; producers are adding optigen by replacing other protein sources, so other ingredients can be added, such as fodder or byproducts, which help in reducing the ration cost in addition to the improvement of rumen health and animal welfare. Balanced ration containing optigen enhance the growth of fibrolytic bacteria which utilizes NPN for development, optimizing microbial protein production and better nitrogen managing environment (Alltech Inc. 2004). Urea is the cheap and most common non protein nitrogen source used in ruminant's feed. Thus, when the prices of other protein source (*i.e.*, canola meal, soybean meal etc.) increase the inclusion of urea as a replacement is feasible because it provides nitrogen to the ruminal microbes to synthesize protein. Domestic animals that were offered NPN compounds show variable results (Forero *et al.*, 1980; Loest *et al.*, 2001). This might be due to faster release of ammonia exceeding the capacity of ruminal microbes to synthesize the protein (Galo *et al.*, 2003). The some slow-release NPN products have efficiently alleviated rapid ammonia production in the rumen (Huntington *et al.*, 2006) and improved the ration efficacy in dairy cows, when soybean meal was replaced with slow release NPN compound. (Golombeski *et al.*, 2006). Keeping in view above facts, this study was designed to evaluate the comparative efficacy of urea and optigen (NPN slow release) on the performance of Nili Ravi buffalo calves.

MATERIALS AND METHODS

Experimental site and design

Fifteen healthy male buffalo calves of the same age and body weight (200±25 kg) were selected and raised at livestock experimental station of Buffalo Research Institute, Pattoki. Calves were divided into three groups, 5 animals in each group. Control group A received basal feed (wanda concentrate + wheat straw + green fodder), group B received basal feed + 1% urea, and group C received basal feed + 1% optigen (%NPN). Animals were given 10 days adaptation period at the start of experiment. At the beginning animals were weighed and then weighed fortnightly during 90 days trial. Animals were placed in separate pens. Feed and water was available *ad libitum*. Feed intake was recorded daily. Table I shows ingredient and chemical composition of diets.

Table I.- Ingredients and chemical composition of feed.

Ingredients	Percentage %	Nutrient	Nutrient composition of feeds (%)		
			A*	B	C
Cotton seed cake	20	CP	16.89	19.70	19.40
Wheat bran	34	Ash	6.50	6.75	6.70
Rape seed cake	03	EE	4.3	4.55	4.6
Maize gluten 30%	18	CF	8.50	9.10	8.95
Molasses	14	NFE	54.21	51.10	51.26
Mineral mixture	01	DM	90.40	91.20	90.91

*A, Control; B, urea supplement; C, optigen; CF, Crude fiber; CP, Crude protein; DM, Dry matter; EE, Ether extract; NFE, Nitrogen free extract.

Average daily weight gain (ADG) and feed intake data were used for the calculation of feed efficiency. Blood samples were collected on

Table II. Mean feed intake (kg), weight gain (kg), feed efficiency, blood glucose (mg/dl) and blood urea nitrogen (mg/dl) of buffalo calves of group A (Control), group, B (Urea) and Group C (Optigen). The data are presented as Mean±SE.

Groups	No. of Obs.	15 d	30 d	45 d	60 d	75 d	90 d	Average daily
Feed intake (kg)								
Control (Basal diet)	5	11.18±0.09	14.40±0.27	17.59±0.39	17.25±0.4	16.32±0.24	16.59±0.21	15.56±0.11[b]
Basal diet + urea	5	11.34±0.16	14.91±0.26	17.96±0.33	17.95±0.35	16.62±0.22	17.09±0.17	15.98±0.15[a]
Basal diet + Optigen	5	10.92±0.13	14.40±0.21	17.07±0.28	17.29±0.28	15.92±0.27	16.20±0.27	15.30±0.14[b]
Weight gain (kg)								
Control (Basal diet)	5	11.18±0.09	14.40±0.27	17.59±0.39	17.25±0.4	16.32±0.24	16.59±0.21	0.61±0.012[c]
Basal diet + urea	5	11.34±0.16	14.91±0.26	17.96±0.33	17.95±0.35	16.62±0.22	17.09±0.17	0.76±0.011[a]
Basal diet + Optigen	5	10.92±0.13	14.40±0.21	17.07±0.28	17.29±0.28	15.92±0.27	16.20±0.27	0.66±0.010[b]
Feed Efficiency								
Control (Basal diet)	5	0.07±0.003	0.045±0.002	0.037±0.004	0.039±0.005	0.042±0.001	0.011±0.006	0.040±0.001[c]
Basal diet + urea	5	0.08±0.001	0.060±0.001	0.049±0.001	0.051±0.003	0.051±0.009	0.017±0.008	0.050±0.003[a]
Basal diet + Optigen	5	0.07±0.005	0.051±0.008	0.041±0.005	0.044±0.001	0.047±0.004	0.015±0.002	0.045±0.005[b]
Blood glucose level (mg/dl) (days)								
Control (Basal diet)	5	50.56±3.41	49.90±2.61	50.28±2.84	50.63±3.22	49.73±2.50	49.95±3.41	50.24±1.22[a]
Basal diet + urea	5	50.61±3.55	51.20±3.55	48.96±2.14	50.36±3.17	49.58±2.22	50.23±3.55	50.14±1.29[a]
Basal diet + Optigen	5	48.82±2.14	49.82±3.04	50.33±4.27	48.76±2.08	49.98±3.19	49.85±2.14	49.36±1.27[a]
Blood urea nitrogen (mg/dl) (days)								
Control (Basal diet)	5	14.35±0.50	14.46±0.31	14.45±0.69	14.51±0.61	14.48±0.64	14.52±0.58	14.45±0.23[a]
Basal diet + urea	5	15.15±0.78	14.76±0.73	14.70±0.78	15.16±0.79	15.20±0.74	15.20±0.81	14.99±0.32[a]
Basal diet + Optigen	5	14.60±0.80	14.85±0.68	14.72±0.72	14.76±0.72	14.97±0.69	14.90±0.68	14.78±0.30[a]

Superscripts with same alphabet indicate NS (p>0.05). Superscripts with different alphabets indicate significant differences (p<0.05)

fortnightly basis 2 hours after feeding. Blood urea nitrogen (BUN) and blood glucose (BG) were analyzed from blood samples at University Diagnostic Laboratory.

Statistical analysis

The experiment was arranged under completely randomized design and the data obtained were subjected to Analysis of Variance Technology. The difference among means was tested through Least Significant Difference Test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

The effects of experimental diets on daily feed intake of fattening male buffalo calves are shown in Table II. Results showed that difference between diets on daily feed intake was significant ($p<0.05$). Calves fed 1% urea (group B) showed increased feed intake than others. These findings are in line with previous studies who explained that increase in feed intake was due to urea treated feed (Trishna *et al.*, 2012; Burque *et al.*, 2008; Nisa *et al.*, 2008; Parsad *et al.*, 1998). However, these findings do not agree with Bourg *et al.* (2012) and Koster *et al.* (2002) who reported that feed intake was unaffected when urea and optigen were added in feed. The effect of increased urea proportion in dry matter intake has been variable. Some workers observed a depression in intake (Forero *et al.*, 1980; Koster *et al.*, 1997), whereas others have reported an increase or no effect (Koster *et al.*, 2002). Higher levels of urea tended to affect the palatability of ration as reported by Erfle *et al.* (1978) in lactating cows. Similarly Pond and Yen (1985) observed lowered feed intake in ewes given basal diet having 1% urea than those fed basal diet alone. Casper and Schingoethe (1986) also noted a depression of dry matter intake in cows fed a concentrate mixture containing urea. In lactating cows, decreased intake of silage and total dry matter due to feeding of urea were reported by Huber *et al.* (1980). In contrast, daily feed intake of bulls given wheat straw and a concentrate mixture with urea at 0, 0.75, 1.50 or 2.25% levels was not adversely affected (Colpan, 1983). Ho Quang *et al.* (1999) also reported that increasing of urea in the feed decreases the intake.

Diets effect significantly ($P<0.05$) daily weight gain in fattening male calves. According to results, daily weight gain were greater for animals fed diet containing 1% urea compared to other diets (Table II). Our findings are in agreement with previous studies (Tedeschi *et al.*, 2002; Trishna *et al.*, 2012; Sarwar *et al*., 2006; Chemjong, 1991) which explained that increase in average daily weight gain was due to urea treated feed. However, Muro *et al.* (2011) disagreed with the results of present study. They reported that slow release NPN (Optigen) has good effect on average daily gain in comparison to urea in Holstein heifers. The addition of urea at 0.5% level to a low protein basal diet (14% nitrogen equivalent) had not been shown to exert any significant influence on weight gain of bulls (Rakhimov *et al.*, 1984). The use of urea at such a low level as employed in the present study did not indicate any adverse effect on the weight gain of the buffalo calves. This tended to suggest that the type of concentrate, *i.e.* low or high protein content did not matter much with respect to growth promotion when urea was fed at lower levels. Similar results were obtained by Reddy and Mudgal (1985) by incorporating urea in a concentrate mixture to provide 50% digestible crude protein. The present results based on the use of urea below 2 % level in male buffalo calves are in agreement with their findings on the weight gain of buffalo heifer calves. This presumably indicated that weight gain in male and female buffalo calves was of the same magnitude with urea fed at levels given above. The present results are also substantiated by those of Sharma *et al.* (1983) who observed no significant difference in weight gains of calves that were fed urea to contribute 60% nitrogen to the rations. Similarly non-significant differences were observed in the weight gain of young male cattle given 2.0% urea in the ration (Holub and Marounek, 1985). It may be stated that feeding urea up to 2.0 % level could be economical in raising buffalo calves under existing farm conditions. On the other hand, Langar *et al.* (I984) showed that in buffalo heifer calves, an addition of 2.3% urea in a concentrate mixture containing maize, groundnut cake and wheat bran did not exert any adverse effect on the weight gains. This probably indicated that the safe limit on the use of urea is between 2.0 and 2.5% level of the diet. A significant improvement in weight gain was observed due to feeding of ammoniated wheat straw under stall-fed condition (Misra *et al.,* 2006). Feed efficiency of animals was significantly affected ($p<0.05$) by experimental diets (Table II). The FE of group B was higher than others. In our study urea treated feed resulted in better feed efficiency. The similar results were also found by Misra *et al.* (2006).

The average blood glucose values showed non-significant ($P>0.05$) difference between all the groups such as group A, B and C had 50.24 mg/dl, 50.14 mg/dl and 49.36 mg/dl, respectively (Table II). Similar findings were reported by Colovos *et al.* (1967). The results of Chaudhary and Srivastava (1996) disagree with our results.

The results of blood urea nitrogen (BUN) in all groups (A, B and C) were non-significant ($P>0.05$) recorded as group A, B and C had 14.45 mg/dl, 14.99 mg/dl and 14.78 mg/dl, respectively (Table II). The findings are in line with Nadeem *et al.* (2014) who explained that the blood urea nitrogen level was unaffected in Nili-Ravi buffaloes. Currier *et al.* (2004) conducted a study in Angus and Hereford cows and observed the effect of urea supplementation on BUN level, contrary to the results of the present study.

CONCLUSIONS

The analysis of the results suggest that addition of 1% urea in the feed of calves can improve feed intake, feed conversion ratio and daily weight gain more efficiently than other NPN sources (optigen). Moreover, use of urea is more economical for fattening of Nili Ravi buffalo calves. Further research should be done to evaluate the ruminal pattern of bacteria in order to better describe the biological effects of urea and slow-release products in the rumen.

REFERENCES

ALLTECH INC., 2004. USA. Global Health Company

Announces Acquisition Animal. Press release. http://www.alltech.com/news/news-articles/2011/11/14/alltech-names-ceo-optigen

ANONYMOUS., 2013-2014. *Economic survey of Pakistan*, Government of Pakistan. Ministry of Finance Economic Advisers Wing. Islamabad, Chapter, 2, pp. 37.

BOURG, B.M., TEDESCHI, L.O., WICKERSHAM, T.A. AND TRICARICO, J.M., 2012. Effects of a slow-release urea product on performance, carcass characteristics and nitrogen balance of steers fed steam-flaked corn. *J. Anim. Sci*., **90**: 3914-3923.

BURQUE, A. R., ABDULLAH, M., BABAR, M.E., JAVED, K. AND NAWAZ, H., 2008. Effect of urea feeding on feed intake and performance of male buffalo calves. *J. Anim. Pl. Sci*., **18**: 1-6.

CASPER, D.P. AND SCHINGOETHE, D.J., 1986. Evaluation of urea and dried whey in diets of cows during early lactation. *J. Dairy Sci*., **69**: 1346-1354.

CHAUDHARY, L.C. AND SRIVASTAVA, A., 1996. Digestion of starch and nitrogen in different parts of alimentary canal of defaunated Murrah Buffalo (*Bubalisbubalis*) calves. *Asian J Anim Sci*., **9**: 667-670.

CHEMJONG, P.B., 1991. Economic value of urea-treated straw fed to lactating buffaloes during the dry season in Nepal. *Trop. Anim. Hlth. Prod*., **23**: 147-54

COLOVOS, N.F., HOLTER, J.B., DEVIS, H.A. AND URBAN, J.R., 1967. Urea for lactating dairy cattle. I. Effect of concentrate fiber and urea levels on the nutritional value of rations. *J. Dairy Sci*., **50**: 518-522.

COLPAN, I., 1983. *Effects of different amounts of urea on feed intake, feed conversion efficiency and live weight gain in young East Anatolian Red bulls*. Ankara Universitesi Veteriner Fakultesi Dergisi, **30**(2): 292-307

CURRIER, T.A., BOHNERT, D.W., FALCK, S.J., SCHAUER, C.S. AND BARTLE, S.J., 2004. Daily and alternate-day supplementation of urea or biuret to ruminants consuming low-quality forage: II. Effects on site of digestion and microbial efficiency in steers. *J. Anim. Sci*., **82**:1518-1527.

ERFLE, J.D., MAHADEVAN, S. AND SAUER, F.D., 1978. Urea as a supplemental nitrogen source for lactating cows. *Canadian J. Anim. Sci*., **58**: 77-86.

FORERO, O., OWENS, F. N. AND LUSBY, K. S., 1980. Evaluation of slow-release urea for winter supplementation of lactating range cows. *J. Anim. Sci*., **50**: 532-538.

GALO, E.S., EMANUELE, M., SNIFFEN, C.J., WHITE, J.H. AND KNAPP, 2003. Effects of a polymer-coated urea product on nitrogen metabolism in lactating Holstein dairy cattle. *J. Dairy Sci*., **86**: 2154.

GOLOMBESKI, G. L., KALSCHEUR, K.F., HIPPENAND, A.R. AND SCHINGOETHE, D.J., 2006. Slow-release urea and highly fermentable sugars in diets fed to lactating dairy cows. *J. Dairy Sci*., **89**: 4395-403**.**

HOLUB, K. AND MAROUNEK, M., 1985. Use of bentonite in urea supplemented diets for fattening cattle. *Krimivarstvia Sluzby*, **21**: 223-226.

HO-QUANG, D., VAN SON, V., ANH KHOA, D.V. AND NGUYEN, T.K.K., 1999. Urea supplementation of rice straw for Sindhi x Yellow cattle; sprayed in solution, as a soft cake or hard block. *Livestock Res. Rural Develop*., **11**: 2-7.

HUBER, J. T., BUCHOLTZ, H.F. AND BOMAN, R.L., 1980. Ammonia versus urea treated silages with varying urea levels in concentrate. *J. Dairy Sci*., **63**: 76-81.

HUNTINGTON, G**.** B.D.L., HARMON, N**.**B**.,** KRISTENSEN, HANSON, K**.**C**.** AND SPEARS, J**.**W**.,** 2006. Effects of a slow-release urea source on absorption of ammonia and endogenous production of urea by cattle. *Anim. Feed Sci. Tech*., **130**: 225-241.

KHAN, M.J., SCAIFE, J.R. AND HOVELL, F.D., 1999. The effect of different sources of urease enzyme on nutritive value of wheat straw treated with urea as source of ammonia. *Asian-Aus. J. Anim. Sci*., **12**: 1063-1067.

KOSTER, H.H., WOODS, B.C., COCHRAN, R.C., VANZANT, E.S., TITGEMEYER, E.C., GRIEGER, D.M., OLSON, K.C. AND STOKKA, J., 2002. Effect of increasing proportion of supplemental N from urea in prepartum supplements on range beef cow performance and on forage intake and digestibility by steers fed low-quality forage. *J. Anim. Sci*., **80**: 1652-1662.

KÖSTER, H.H., COCHRAN, R.C., TITGEMEYER, E.C., VANZANT, E.S., NAGARAJA, T.G., KREIKEMEIER, K.K. AND ST. JEAN, G., 1997. Effect of increasing proportion of supplemental nitrogen from urea on intake and utilization of low-quality, tallgrass-prairie forage by beef steers. *J. Anim. Sci*., **75**: 1393-1399.

LÖEST, C.A., TITGEMEYER, E.C., DROUILLARD, J.S., LAMBERT, B.D. AND TRATER, A.M., 2001. Urea and biuret as non-protein nitrogen sources in cooked molasses blocks for steers fed prairie hay. *Anim. Feed Sci. Tech*., **94**: 115–126.

LANGAR, P.N., MAKKAR, G.S. AND BAKSHI, M.R.S., 1984. Comparative studies on the urea and fibre utilization in buffalo and cattle. *Indian J. Anim. Sci*., **54**: 413-419.

MURO, E., CARLOS, D. AND MARCELO, M., 2011. *Field evaluation of concentrate diets formulated with Optigen® and urea as the main source of crude protein, compared with sunflower meal*. Proceedings of Science and Technology in the feed industry, 27th International Symposiums, pp. 154-157.

NADEEM, M.S., PASHA, T.N., JABBAR, M.A., JAVED, K., KHAN, M.Z., NAVEED, S. AND DITTA, Y.A., 2014. Effect of different non-protein nitrogen (NPN) on performance of lactating Nili-Ravi buffaloes. *J. Anim. Pl. Sci*., **24**(Suppl. 1): 1-4.

MISRA, A. K., MEHRA, U.R. AND DASS, R.S., 2006. Assessment of feeding urea ammoniated wheat straw on growth performance, feed intake and nutrient utilization in crossbred calves reared under stall-fed or grazing condition. *Livestock Res. Rural Develop*., **18**: 58-64.

NISA, MU., JAVAID, A., SARWAR, M., BHATTI, S.A. AND AMJAD, M.S., 2008. Productive Parameters affected by Protein fractions in Ruminants. *Pak. J. agric. Sci*., **45**: 315-321.

PRASAD, R.D.D., REDDY, M.R. AND REDDY, G.V.N., 1998. Effect of feeding baled and stacked urea treated ricestraw on the performance of crossbred cows. *Anim. Feed Sci. Tech.,* **73**: 347-352.

POND, W.G. AND YEN, L.H., 1985. Changes in concentrations of rumen and blood constituents in ewes during adaptation to dietary urea with and without supplemental clinoptilolite. Nutrition Reports international, **32**: 425-437

RATH, S.S., VERMA, A.K., SINGH, P., DASS, R.S. AND MEHRA, U.R., 2001. Performance of growing lambs fed urea-ammoniated and urea supplemented based diets. *Asian-Aust. J. Anim. Sci.*, **14**: 1078-83.

REDDY, N.S. AND MUDGAL, V.D., 1985. Comparative efficiency of urea and biuret as nitrogen supplements for buffalo heifers. *Indian J. Anim. Sci.,* **55**: 444-450.

RAKHIMOV, K.R., KORDYUKOV, A.P. AND SKOROBOGATYKH, N.N., 1984. Nitrogen retention in young fattening bulls given urea by various means. *Refcrativnyi Z.*, **58**: 11-12.

SARWAR, M., NISA, M.U., HASSAN, Z. AND SHAHZAD, M.A., 2006. Influence of urea molasses treated wheat straw fermented with cattle manure on chemical composition and feeding value for growing buffalo calves. *Livestock Sci.,* **105**: 151-161.

SATTER, L.D. AND ROFFLER, R.E., 1975. Nitrogen requirement and utilization in dairy cattle. *Dairy Sci*., **58**: 1219–1237.

SHARMA, V.K., DHLMAN, T.R. AND NARANG, M.P., 1983. Effect of urea feeding on growth of jersey calves. *Indian J. Anim. Sci*., **53**: 358-361.

STEEL, R.G.D., TORRIE, J.H. AND DICKEY, D.A., 1997. *Principles and procedures of statistics. A biometrical approach*. 3rd edition, Mc Graw Hill Book co, New York USA.

TEDESCHI, L.O., BAKER, M.J., KETCHEN, D.J. AND FOX, D.G., 2004. Performance of growing and finishing cattle supplemented with a slow-release urea product and urea. *Can. J. Anim. Sci.*, **82**: 567-573

TRISHNA, B.K., DUTTA, S., KAYASTHA, R.B. AND DEKA, R.S., 2012. Growth Performance and nutrient utilization of growing calves with urea treated wheat straw based ration. *Indian J. Dairy Sci.*, **65**: 435-438

(Received 9 March 2015, revised 3 April 2015)