EFFECT OF AUGMENTED FEEDING WITH BYPASS AMINO ACIDS AND SLOW-RELEASE NON-PROTEIN NITROGEN SUPPLEMENTS ON MILK PEAK, LACTATION PERSISTENCY, MILK QUALITY AND POST-PARTUM REPRODUCTIVE PERFOMANCE OF BRAZILIAN BUFFALOES

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ABSTRACT

A total of 25 pregnant and primiparous Brazilian buffaloes were used in this study to determine the effects of augmented feeding with bypass amino acids (BPAA) and slow-release non-protein nitrogen (SRNPN) supplements on milk peak, lactation persistency, milk quality and post-partum reproductive performance. Individual cows were allotted to 5 dietary treatments using a randomized completed block design. The dietary treatments were without (control) or with augmented feeding (AF), AF supplemented with bypass amino acids (BPAA); AF supplemented with slow-release non-protein nitrogen (SRNPN), and AF supplemented with BPAA and SRNPN. There were 5 cows per treatment and each cow served as a replicate. The feed ration was composed of corn silage (67.3%), rice straw (9.5%) and dairy concentrate pellets (23.2%). The supplementary concentrates, BPAA, and SRNPN were given at 0.5kg/kg of milk production, 100 g and 50 g/(hd·d), respectively. Augmented feeding alone or with supplementary SRNPN resulted in greater (*P*<0.05) milk peak compared with the other treatments. Dairy buffaloes with AF alone or with supplementary BPAA and SRNPN had the

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greatest (*P*<0.05) 305-d adjusted total milk yield among the treatments. No significant differences were observed on lactation persistency and post-partum reproductive performance. Dairy buffaloes under AF supplemented with BPAA had greater (*P*<0.05) milk fat and total solids contents compared with the rest of the treatments. The use of augmented feeding with BPAA and SRNPN supplements resulted in greater net income of P33,762 per lactation. In conclusion, augmented feeding alone or with BPAA and SRNPN supplements in dairy buffaloes improves ADG, nutrient utilization and milk production.

Keywords: Augmented feeding, Bypass amino acids, non-protein nitrogen, dairy buffaloes

INTRODUCTION

The peak of milk production is an important indicator in developing appropriate nutrition for dairy cows. Peak yield is achieved when the lactating cow reaches the highest production level during its entire lactation period. Normally, the cow exhibits milk peak at 45 to 90 days in milk (DIM), followed by the gradual decline in milk production over time until the animal completely dries-off (Anwar, 2009). The milk yield and the average days to peak-milk are important parameters in assessing the lactation performance of the cows (Habib, 2009). During lactation, the peak of production is followed by the rate of decline in the milk yield of the cow which is also known as lactation persistency. On the average, the reported persistency of lactation of a cow is about 94 to 96% (Drackley, 1999). After attaining the milk peak, milk yield drops by 0.2%/d during the first calving and 0.3% decline/d in succeeding lactations (Capuco *et al.*, 2003). The importance of good nutrition and proper management practices are recognized especially during the transition period or at the peak of lactation of the cows.

In dairy animals, the efficiency of protein utilization for maintenance and for milk production is 60%, which is less efficient than in poultry and swine (70-80%; Satter and Roffler, 1977). About 40-50% of the total protein requirement of ruminants is supplied in the form of microbial protein (Russell and Strobel, 1989). The microbial protein supply for the animal is however, dependent on the turnover rates or the supply of nitrogen in the rumen. Reports showed that in lactating cows, Met and Lys are some of the limiting amino acids involved in microbial protein synthesis. Post-ruminal infusion of Met and Lys in dairy cows increased milk production, improved milk protein (3.15% points) and milk fat (3.88%) contents (Socha *et al.*, 1994). The increase in milk fat content was observed due to the enhanced *de novo* synthesis of short and medium-chain fatty acids in the mammary gland.

The cheapest source of nitrogen to enhance microbial protein synthesis is urea. The utilization of urea by the rumen microbes is dependent on the synchronicity or the supply of readily available energy source. To synchronize the utilization of NPN with energy source, a technique such as the encapsulation of NPN with fat or with other chelating compounds to slowly release the NPN source was found effective. Lyons (2009) showed that slow release NPN as feed supplement to dairy buffaloes improves milk production and fat content. This was due to the improvement in rumen functions leading to increased fiber degradation and enhanced microbial protein turnover in buffaloes. Replacing the high protein diet with slow-release NPN source may be considered a cost effective dietary supplement for dairy buffaloes.

In this study, the peak of lactation, lactation persistency, milk quality and the subsequent reproduction of dairy buffaloes were evaluated when the animals were subjected to augmented feeding with bypass amino acids (BPAA) as source of rumen undegradable nitrogen (RUP) and the use of slow release NPN (SRNPN) supplement as source of rumen degradable protein (RDP) for enhancing the productivity of the animals. Specifically, the objectives of this study were:

1. To determine the effects of supplementary bypass amino acids and slow release NPN on the yield and quality of buffalo milk.
2. To determine the peak-milk and persistency of lactation of dairy buffaloes
3. To evaluate feed intake, nutrient utilization and digestibility of dairy buffaloes fed with dietary treatments.
4. To assess the post-partum reproductive performance of dairy buffaloes

5. To come-up with a simple cost analysis of the implemented interventions on dairy buffaloes.

MATERIALS AND METHODS

Twenty five (25) pregnant and primiparous Brazilian buffaloes were used in this study. The cows which on their last 2 months of pregnancy were allotted using a randomized complete block design to 5 dietary treatments, namely; without (T1) or with (T2) augmented feeding, T2 plus supplementary bypass amino acid (BPAA, T3); T2 plus supplementary slow-release non-protein nitrogen (SRNPN, T4), and T2 plus supplementary BPAA and SRNPN (T5). There were 5 cows per treatment and each cow serves as a replicate.

Feeding management

The basal ration (Table 1) is composed of corn silage and rice straw. Concentrate supplement was given to the cows as per the requirement of each treatment. Supplementary molasses, mineral mix and salt were offered on top of their ration of the cows immediately after calving to the 6 months of lactation. All the cows were raised under complete confinement throughout the duration of the study.

Table1. The dietary rations used on as fed basis.

Item	Treatment				
	T1	T2	T3	T4	T5
	Con-trol	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
Corn silage, kg	20.3	17.8	17.0	16.0	17.8
Rice straw, kg	2.6	2.1	2.2	3.1	2.5
Dairy conc. pellets, kg	4.6	6.6	6.4	6.3	6.6
BPAA, kg	--	--	0.1	--	0.1
SRNPN, kg	--	--	--	0.05	0.05
Mineral mix, kg	0.1	0.1	0.1	0.1	0.1
Salt, kg	0.1	0.1	0.1	0.1	0.1
Molasses, kg	0.9	0.9	0.9	0.9	0.9
Total	**28.6**	**27.6**	**26.8**	**26.55**	**28.15**

Digestibility trial

During the third month of the study, a digestibility trial was conducted involving three replicate cows from each treatment group. Before the digestibility trial, the replicate cows were first weighed to determine their live weights. A total fecal collection procedure for 24 h was followed for 5 consecutive days. Collection of samples such as fecal samples, forage/feed offered and orts was done accordingly. The collected samples for 5 days were dried, ground and analyzed for its nutrient composition.

Housing management

All the cows were raised under complete confinement with individual stall having a floor area of 18 m^2. Each pen is equipped with feeding and automatic drinking troughs. The cows were kept in their stall through-out the duration of the trial to complete the whole lactation period of 300 days. Cleaning and disinfection of the cows' pen were done regularly.

Management of parturient cows

Approximately one week before parturition, the body weight of the cows was determined using a digital balance. Assistance was provided to the cow during parturition. Soon after calving, the calves were separated from their dams and zero-suckling was practiced in calf rearing. Other management practices such as hoof trimming and flashing of the uterus of the cows with iodine were done.

Milking management

The lactating cows were milked following the milking procedure developed by PCC-GP farm. Milking was done twice a day using 2 x 6 tandem type milking machine. The morning milking starts at 0400 and 1500 H for the afternoon milking. The daily milk production of the cows was recorded. Monthly milk samples were collected and analyzed for nutrient composition and somatic cell counts using Milko-scan and somatic cell counter, respectively.

Breeding management

The cows were monitored for their reproductive performance such as post-partum estrus, service period and conception rate. Estrus observations followed by artificial insemination and pregnancy diagnosis of the cows were done by the assigned PCC-

GP farm AI technician. If the cows did not conceive after 3 inseminations, these were subjected to natural mating by a cleaned-up bull.

Health management

The health management program developed by PCC was followed to maintain the healthy conditions of the cows. Vaccination against HS and Sura was employed. Ovarian palpation to determine the condition of the uterus, and the presence of cystic ovaries was also done by the farm AI technician. Monitoring of the incidence of mastitis using CMT and somatic cell analysis among cows was practice regularly at the farm.

Data gathered

1. Change in BW – this was determined before and immediately after calving and continuously followed up to 10 months of lactation. The monthly body weights of the experimental animals were determined using a Rudd-weigh digital balance. The weight data were expressed in total weight gain or ADG.
2. Feed/nutrient intake – the daily feed is expressed on as feed or dry matter/day or DMI as % of the animals' live weight of the cows. The protein, calcium and phosphorus intake of the dairy buffaloes were also determined.
3. Nutrient digestibility – the data gathered were expressed in DM and protein digestibility.
4. Milk production and days in milk – milk yield was expressed in adjusted daily and monthly milk production. The lactation period was expressed in days in milk.
5. Milk peak and persistency - the milk peak is reported as the highest daily milk yield produced by the cow in its entire lactation. The persistency of milk production is determined by dividing the current monthly milk production by the last month's milk yield of the cow and is expressed in a percentage unit.
6. Milk quality – milk samples from each cow was collected and analyzed monthly using Milko-scan and somatic cell counter. The milk quality was expressed in terms of milk fat, lactose, protein, total solids, solid non-fat and somatic cell count.
7. Reproductive performance – this was determine by close monitoring and recording of the reproduction data involving

the first post-partum estrus, the service period and the percent conception rate through artificial insemination.

8. Health parameters – the reproductive problem, mastitis, morbidity and mortality cases were monitored during the course of the study
9. Cost analysis – the income derived from the augmented feeding with BPAA and SRNPN supplements were calculated.

Statistical analyses

Data were analyzed using ANOVA for a randomized complete block design. Pairwise comparisons of treatment means were performed using the Duncan's Multiple Range Test. Statistical significance were set at $P \leq 0.05$ for all statistical tests.

RESULTS AND DISCUSSION

Changes in body weight of the cows

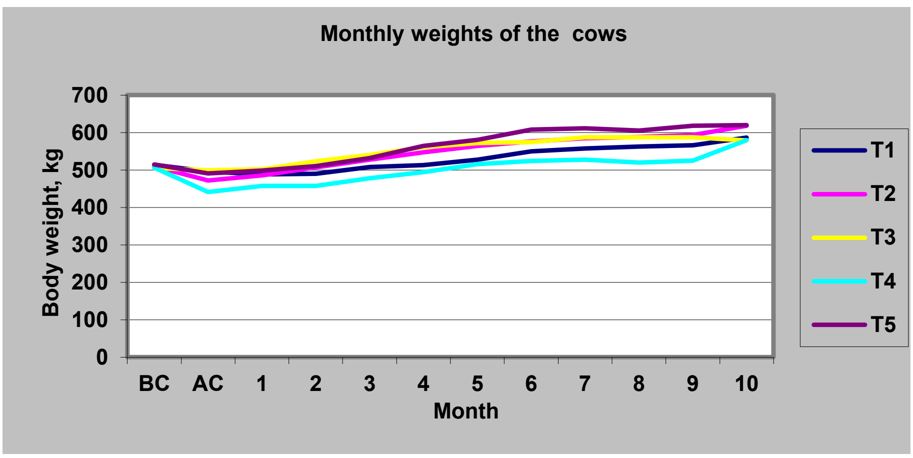
The pregnant buffaloes had an average BW of 510 kg one week before the expected date of calving. After calving, the animals' average BW decreased to 477.9 kg for an equivalent weight loss of 32.1 kg. The greatest weight loss was observed in T4 with 45 kg and the least weight loss was in T5 with 24 kg after calving. If the average weight loss of the dams is compared to the average BW (34.5 kg) of the calves born (Table 2), there was a difference of 2.4 kg in favor of the calves' weight.

Monthly weights of the cows increased during the entire 10-month period of the study (Figure 1). This indicated that the primiparous cows have not yet attained their mature weight. The greatest ADG (0.47 kg) was observed in cows subjected to challenge feeding with supplementary BPAA and SR-NPN (T5) followed by the cows subjected to challenge feeding using supplementary dairy concentrate pellets (T2, 0.45 kg). Both treatments had greater ($P<0.05$) ADG when compared to the control, T3, and T4 cows. These findings suggest that the nutrients supplied to cows by T2 and T5 not only supplied the requirements for growth but also the nutrients for milk production.

Table 2. Change in body weight of dairy buffaloes fed without (control) or with augmented feeding (AF) supplemented with bypass amino acids (BPAA), slow release non-protein nitrogen (SRNPN), and their combination.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
BW before calving, kg	514.2	509.4	505.6	506.2	514.6
BW after calving, kg	486.2	472.2	479.2	461.2	490.6
BW loss, kg	28.1[a]	37.2[b]	26.4[a]	45.0[c]	24.0[a]
ADG of cows	0.26[a]	0.45[b]	0.32[a]	0.31[a]	0.47[b]

[a-c]Within a row, means without a common superscript differ (P<0.05).



Feed intake and nutrient digestibility

The DMI, DMI as % of BW, and the daily protein intake of the cows were not significantly affected by the dietary treatments used in the study (Table 3). The observed data on DMI as % of BW in all treatments were in agreement with the range of DMI as % BW of lactating buffaloes previously published (Kearl, 1982), which ranges between 2.0 to 3.5% of the animal's BW.

Table 3. Dry matter and nutrient intake and digestibilities (%) in dairy buffaloes fed without (control) or with augmented feeding (AF) supplemented with bypass amino acids (BPAA), slow release non-protein nitrogen (SRNPN), and their combination.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
Daily DM intake (DMI), kg	13.59	14.33	13.89	14.43	14.69
DMI as % BW	2.40	2.30	2.40	2.50	2.40
Daily CP intake, kg	1.56	1.78	1.69	1.70	1.81
Ca intake, g	101.0[a]	129.0[b]	118.0[b]	118.0[b]	129.0[b]
P intake, g	48.0[a]	63.0[b]	59.0[b]	63.0[b]	60.0[b]
DM digestibility, %	66.6[a]	68.5[b]	67.0[a]	68.2[b]	69.5[b]
CP digestibility, %	63.7[a]	68.0[b]	64.5[a]	68.0[b]	68.5[b]

[a,b]Within a row, means without a common superscript differ (*P*<0.05).

Cows subjected to AF alone or with BPAA and/or SRNPN supplements had higher (*P*<0.05) Ca and P intakes than the control cows. In lactating cows, adequate levels of Ca and P in the ration is important because these macro-minerals are important in the synthesis of milk.

Lactating cows fed T2, T4 and T5 rations had greater (*P*<0.05) DM and CP digestibility compared with the cows fed the control and T3 rations. The observed differences in digestibility indicate that the DM contents of the corn silage, concentrates and rice straw, which are the major components of the rations, were most digested both by the microbes in the rumen and the host animals.

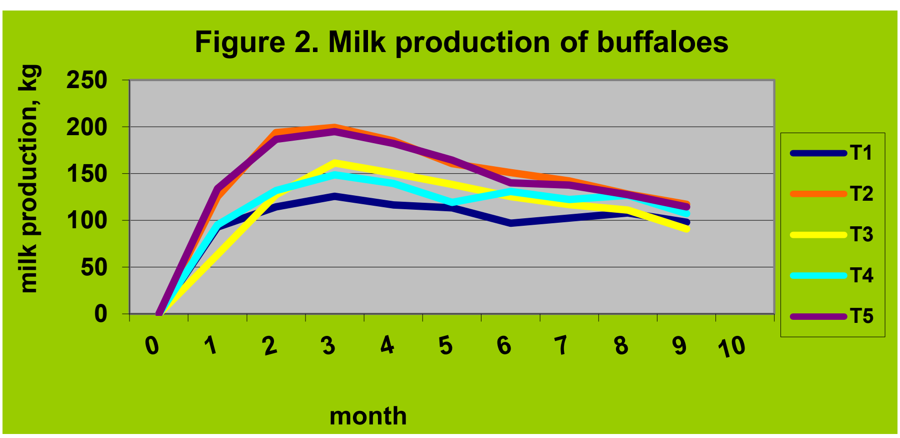
Milk production, composition and persistency of lactation

Dairy buffaloes fed T2 and T5 had the greatest (*P*<0.05) 305 day adjusted total milk yield among the treatments (Table 3). The observed higher intakes of Ca and P by the cows in T2 and T5 primarily supplied by the concentrates and the mineral mix may have contributed to the significant increase in milk production. Augmented feeding supplemented with BPAA or SRNPN, however, did not improve 305-day adjusted total milk yield compared with those fed the control treatment. In this study, the average milk peak of the cows was observed on the 74th day-in-milk. This was consistent with Anwar (2009) that milk peak in buffaloes is exhibited during 45 – 90 days-in-milk. Buffaloes given AF alone and AF + SRNPN had the highest (P<0.05) milk peak of 12.0 kg/d at 68 days in milk and 12.5 kg/d at 66 days in milk, respectively. No significant differences in milk peak were observed between the buffaloes fed AF + BPAA and AF + BPAA+ SRNPN; however, both treatments had higher (P<0.05) milk peak compared with the control cows.

Table 4. Peak milk, average peak-day, milk yield and persistency of lactation of dairy buffaloes fed without (control) or with augmented feeding (AF) supplemented with bypass amino acids (BPAA), slow release non-protein nitrogen (SRNPN), and their combination.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
Peak-milk, kg/d	8.4[a]	12.0[c]	10.6[b]	12.5[c]	10.0[b]
Average peak-day	78	68	89	66	71
Adj. 305 d milk yield, kg	1,121[a]	1,433[b]	1,280[a]	1,226[a]	1,586[b]
% Lactation persistency	93.6	91.5	91.0	91.5	91.6

[a-c]Within a row, means without a common superscript differ (P<0.05).



In terms of persistency of lactation, there were no significant differences observed among the dairy buffaloes fed the five dietary treatments. The observed lactation persistency of 92% was in agreement and was very close to the reported ideal lactation persistency of 95% in buffaloes (Drackley, 1999).

On milk quality, the animals given challenge feeding with supplementary BPAA had greater (*P*<0.05) milk fat and total solids contents compared with the rest of the treatments (Table 5). Milk protein, lactose and solids non-fat was not significantly affected by the dietary treatments including the milk produced by the control group. The highest somatic cell counts of 151.8^{03}/ml of milk was observed from buffaloes given AF + SRNPN. It can be noted that the SCC values (200^{03} /ml) gathered were acceptable and has passed the SCC standards for buffalo milk.

Table 5. Composition of buffalo milk in dairy buffaloes fed without (control) or with augmented feeding (AF) supplemented with either bypass amino acids (BPAA), slow release non-protein nitrogen (SRNPN), or their combination.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
% Fat	7.04[a]	6.10[a]	9.72[b]	6.79[a]	7.34[a]
% CP	4.33	4.69	5.00	4.41	4.70
% Lactose	4.63	4.78	4.36	4.34	4.65
% Total solids	16.15[a]	16.29[a]	18.98[b]	15.63[a]	16.34[a]
% Solids non-fat	8.99	9.51	9.20	8.84	9.24
Somatic cell counts, '000/ml	52.18[a]	82.15[ab]	91.01[ab]	151.83[c]	70.36[ab]

[a-c]Within a row, means without a common superscript differ (*P*<0.05).

Post-partum reproductive performance

There were no significant differences among the treatments on service period, conception rates, and number of services per conception (Table 6). The earliest post-partum estrus of the experimental buffaloes was observed at 42 d. However, with an average of 146 d service period, 80% of the post-partum buffaloes were already confirmed pregnant through AI.

In this study, the average service period (146 d) recorded was longer than the report of Alexiev (1998) in Bulgarian buffaloes, which is from 90-122 d post-partum. The longer service periods observed in the current study may be due to the system used in estrus detection. The animals were kept in individual stalls and the estrus detection was done by the assigned night-shift caretaker. Unlike in breeding herds where cows/heifers are raised in groups, detection is easy because of the use of a vasectomized bull which helps facilitate the observation of cows that are on estrus. Mounting behavior is one of the normal signs of estrus observed in the group of breeding herd but in this study, mounting behavior is not possible since the cows were housed individually in their stall.

Table 6. Post-partum reproduction of dairy buffaloes fed without (control) or with augmented feeding (AF) supplemented with either bypass amino acids (BPAA), slow release non-protein nitrogen (SRNPN), or their combination.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
Service period, d	167	142	161	152	106
Conception rate, %	80	80	80	80	80
No. of services/conception	1.50	2.00	2.30	2.00	2.25

Cost analysis

Data showed that T5 and T2 gave the highest revenues of P334.90 and P306.37/hd/d and these were greater compared to the revenues from the control, T3 and T4 groups. In terms of profitability, T5 and T2 also gave the highest net profit of P33,762 and P25,881/lactation, respectively. The cows subjected to AF + SRNPN had the lowest net profit of P9,540.

Table 7. Simple cost analysis on the effects of augmented feeding (AF) with bypass amino acids (BPAA) and slow release non-protein nitrogen (SRNPN) supplements in lactating buffaloes.

Item	Treatment				
	T1	T2	T3	T4	T5
	Control	AF	AF + BPAA	AF + SRNPN	AF + BPAA + SRNPN
Revenues					
Milk production	1,120.90	1,433.20	1,280.60	1,225.80	1,586.40
Sales of milk, PhP/d	186.80	238.87	213.43	204.30	264.40
ADG of cows	0.26	0.45	0.32	0.31	0.47
Equivalent value of ADG @ P150/kg lean	39.00	67.50	48.00	46.50	70.50
Gross revenue, PhP	225.80	306.37	262.43	250.80	334.90
Expenses					
Feed cost	142.67	174.35	159.31	173.35	176.70
Labor cost	24.24	24.24	24.24	24.24	24.24
Biologics	1.42	1.42	1.42	1.42	1.42
Miscellaneous	20.00	20.00	20.00	20.00	20.00
Total expenses, PhP	188.33	220.10	205.00	219.01	222.36
Net revenue, PhP/hd/d	37.41	86.27	57.43	31.80	112.54
Net income/ lactation, PhP/hd	11,223	25,881	17,229	9,540	33,762

CONCLUSION

Augmented feeding alone or with BPAA and SRNPN supplements in dairy buffaloes improves ADG, nutrient utilization, and milk production. Therefore, this is recommended in feeding dairy buffaloes and for farmer's adoption because this does not only increase nutrient utilization and milk production of buffaloes, but may also significantly increase income of dairy farmers.

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