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EFFECT OF *Leucaena leucocephala*-BASED MULTI-NUTRIENT LICK BLOCKS ON THE FEED INTAKE AND GROWTH PERFORMANCE OF BUFFALOES

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ABSTRACT: Ruminant production in the Philippines is often hindered by limited access to high-quality feed, leading to suboptimal animal growth and productivity. To address these challenges, this study evaluated the locally made multi-nutrient lick block (MNLB) containing ipil-ipil (*Leucaena leucocephala*), a legume known for its nutritional value. A 30-day palatability test was conducted to assess the acceptability of the developed MNLB, using 5 male buffaloes with an average weight of 245 ± 5 kg. Additionally, a 90-day-feeding trial was carried out using 15 growing buffaloes (average age: 13.5 months, weight: 243.83 ± 5 kg), randomly assigned to three treatment groups: T1 or control (non-supplemented), T2 or commercial mineral block, and T3 or MNLB, to evaluate the growth performance, nutrient utilization, and economic viability of the legume-based MNLB. Results demonstrated that the MNLB was palatable to the animals, with an average daily consumption of 192.10 g/animal/day, providing adequate nutritional value to meet the buffaloes' daily requirements. Moreover, MNLB supplementation significantly enhanced dry matter (DM) and crude protein (CP) intake compared to control and commercial mineral block groups. The average DM intake for T3 was 9.88 kg, and the average CP intake was 1006 g, compared to T1 (9.56 kg DM intake and 983 g CP intake) and T2 (9.59 kg DM intake and 984 g CP intake). While the commercial mineral block showed positive results, the MNLB outperformed in terms of nutritional value. In terms of cost-effectiveness, the MNLB can serve as an alternative feed supplement for small- scale farmers, offering a lower- cost option compared to commercial feed supplements. The study concluded that the MNLB has potential as a practical solution to address the nutritional challenges faced by ruminant producers in resource-limited environments. By providing a nutrient-rich and safe feed supplement, the MNLB can contribute to improved animal health, productivity, and overall farm profitability.

Keywords: Legume, *Leucaena leucocephala*, Multi-nutrient supplementation, Ruminants, Urea based feed supplements, Water buffalo.

INTRODUCTION

In developing countries like the Philippines, ruminant producers face considerable challenges due to the limited and inconsistent availability of high-quality animal feed (Liang and Paengkoum, 2019). The scarcity of nutrient-dense fodder compounded by seasonal fluctuations in forage quality, often leads to nutrient deficiencies, which hinder optimal animal growth, reproduction, and overall productivity. These challenges are particularly prevalent among smallholder farmers, who frequently rely on low-quality feed resources such as crop residues and poor-quality roughages, further exacerbating the issue of undernutrition in livestock (Choudhary et al., 2021).

To address the nutritional needs of ruminants, various feed supplementation strategies have been explored, with multi-nutrient blocks (MNBs) emerging as a widely adopted solution in many regions. MNBs are solidified blocks containing a mixture of nutrients such as urea (a source of non-protein nitrogen), molasses, di-calcium phosphate, vitamins, and minerals, all formulated to enhance rumen fermentation, improve digestion, and boost growth performance in ruminants (Khan et al., 2017; SungChinTial et al., 2023). The use of these blocks has been shown to stimulate microbial growth in the rumen, thereby improving the digestion of fibrous feeds and increasing nutrient absorption, which in turn enhances productivity, particularly in animals on low-quality diets (Reshi et al., 2022; Villanueva Pedraza et al., 2023).

Supplementing ruminant diets with multi-nutrient feed blocks has proven beneficial in improving various performance parameters. For instance, Kachhawaha et al. (2022) highlighted the positive effects of Multi-Nutrient Feed Blocks (MNFB) as a supplement for lactating buffaloes, resulting in improved milk yield, milk fat content, general health status, and reproductive performance. These findings (Kachhawaha et al. 2022; Reshi et al., 2022; Villanueva Pedraza et

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al., 2023) underscore the potential of multi-nutrient supplementation in overcoming nutritional deficiencies and enhancing livestock productivity in resource-limited environments.

Despite the documented advantages of MNBs, their adoption among small-scale farmers in the Philippines remains limited. A key barrier to widespread use is the inclusion of urea, a non-protein nitrogen source that, while beneficial in controlled amounts, poses toxicity risks when consumed in excess. Urea poisoning is a significant concern, particularly in regions where farmers may lack the technical knowledge to manage proper dosing (Reshi et al., 2022; Gimelli et al., 2023). This fear of urea toxicity has led to low adoption rates, limiting the potential benefits of MNBs for improving ruminant nutrition in the country.

To mitigate the risks associated with urea, alternative feed formulations are being explored. One promising approach is the development of multi-nutrient lick blocks (MNLB) incorporating ipil-ipil (*Leucaena leucocephala*), a leguminous plant known for its high protein content. Ipil-ipil offers a safer, nutrient-rich alternative to urea, reducing the reliance on non-protein nitrogen while maintaining or enhancing the nutritional benefits of the supplement. By incorporating ipil-ipil, MNLBs can provide a more natural, balanced source of protein, which may lead to improved animal health and reduced risk of urea toxicity.

This study was conducted to evaluate the nutritional and economic benefits of a novel MNLB formulation that utilizes ipil-ipil as a key ingredient. Specifically, the research aimed to: 1) determine the nutritional composition of the MNLB, 2) assess its impact on the growth performance of water buffaloes through controlled feeding trials, and 3) evaluate its economic viability as a feed supplement for smallholder farmers. By addressing these objectives, this study seeks to contribute to the development of sustainable and innovative feed supplementation strategies that can help overcome the challenges faced by ruminant producers in the Philippines. Furthermore, it highlights the potential for locally sourced, high-protein leguminous plants to play a pivotal role in improving the productivity and profitability of ruminant farming in resource-limited environments.

MATERIALS AND METHODS

The study was conducted at the Gene Pool Farm of the Department of Agriculture- Philippine Carabao Center National Headquarters and Gene pool, Science City of Munoz, Nueva Ecija, to determine the effect of legume based multi-nutrient block on the growth performance of growing buffalo.

Preparation and mixing of MNLB

The preparation and mixing of MNLB were carried out following standard procedures to ensure consistency and accuracy of the final product. First, the ipil-ipil leaves were collected and sun-dried. Once dry, the leaves were milled to increase the surface area for better mixing. Before mixing with other ingredients, the urea was crushed or ground to increase its solubility. It was then added to molasses in a large basin or drum and mixed continuously until all the urea grains dissolved completely. In a separate container, the other ingredients such as rice bran, pulverized ipil-ipil, cement, salt, dicalcium phosphate, vitamins, and mineral mix were combined and mixed thoroughly. The two mixtures were then mixed together. Mixture 1 (molasses and dissolved urea) was added gradually to Mixture 2 (rice bran, ipil-ipil, cement, dicalcium phosphate, mineral mix, and salt) while continuously mixing until a homogeneous dough texture was achieved. The final mixture was weighed using a top-loading weighing balance, and about 5kg of the mixture was compacted using a customized fabricated molder (Figure 1) to produce MNLB of the desired shape and size. The blocks were then sun dried for 30 to 35 days (Figure 2). This method ensured the consistent composition of each block, enabling accurate dosing and efficient nutrient delivery to animals.

Figure 1 - Improvised molder for multi-nutrient lick block production

Figure 2 - Sun drying of MNLB for 30 to 35 days

Nutrient composition of MNLB

The chemical composition of the MNLB was analyzed through a series of tests. Initially, the samples from each treatment were oven-dried at 60 ℃ for 72 hours to remove moisture content (% MC). Subsequently, the temperature was raised to 135 ℃ for 2 hours to determine the % MC. The ash content (% Ash) and crude protein (CP) content (% CP) were then analyzed using the standard method of the Association of Official Analytical Chemists (AOAC, 1995). The dry matter (DM) content (% DM) was calculated by subtracting the % MC from 100%. Additionally, mineral analysis was conducted by sending MNLB samples to a third-party laboratory for analysis using Atomic Absorption Spectroscopy (Shimadzu Corp., Kyoto, Japan). This analysis determined the concentrations of essential minerals such as manganese (Mn), phosphorus (P), calcium (Ca), sodium (Na), copper (Cu), zinc (Zn), and selenium (Se). These analyses provided valuable insights into the nutritional content of the MNLB, guiding further improvements in its formulation and ensuring its efficacy as a feed supplement for water buffaloes.

Palatability test and evaluation of the effect of MNLB on growth performance of growing buffaloes

Palatability Test

Preliminary trials were conducted at Philippine Carabao Center National Headquarters and Gene Pool farm using animals ≥ 1 year old to assess the palatability of the MNLB (Figure 3). Five male buffaloes of similar age and average weight of 245 ± 5 kg were individually housed to accurately measure intake and preference. Each animal received the same diet of grass and concentrates twice daily along with MNLB. Clean and fresh drinking water was made available all throughout the experiment. The weight of blocks was recorded weekly to determine the average daily intake of animals for optimal MNLB consumption.

Figure 3 - Palatability and acceptability trial set-up.

Evaluation of the effect of MNLB on growth performance of growing buffaloes

Experimental animals and treatment

Fifteen apparently healthy, riverine type growing male buffaloes between 13-16 months old (average 13.56 months) and weighing approximately 243.83 ± 5 kg were selected for this experiment. The animals were randomly assigned to three treatments with five replicates per treatment: Treatment 1: Negative Control (no MNLB or commercial mineral block provided), Treatment 2: Positive Control (provided commercial mineral block, Red Rockies brand), and Treatment 3: Supplemented with MNLB.

Feeds and feeding management

The sample ration with a 65:35 forage-to- concentrate ratio for 14- month- old growing animals, averaging 250 kg body weight and targeting an average daily gain (ADG) of 500 grams, was formulated using the KBGAN iFEED© mobile app (Palacpac et al., 2024; Table 1). The initial weight, monthly and final weight of the animals were recorded to determine the total weight gained and the ADG. The selected growing buffaloes were fed a formulated ration consisting of Napier grass, rice straw, and concentrate feed to meet their daily nutritional requirements (Table 1) (Kearl, 1982) for a 90-day feeding trial period. Roughage was provided ad libitum in the morning for consumption throughout the day, while concentrate was given in the morning, before the roughage. The blocks were hung above the animals to allow for free licking while preventing overconsumption.

Table 1 - Formulated TMR ration (total mixed ration) based on the requirement of the animals

T3 Diet (feed materials)	DM (%)	CP (%)	TMR Ration (DM basis)		Fresh wt. (kg)
Napier grass	17	7.98	45.00		13.76
Grower concentrate	88	16.00	35.00		2.07
Rice straw	94.93	4.00	20.00		1.10
Total	-	-	100.00		16.93
Ration	**DM (kg)**	**CP (g)**	**TDN (kg)**	**Ca (g)**	**P (g)**
Requirement	5.90	604.00	3.55	15.00	12.00
Diet	5.90	689.56	3.61	31.12	21.54

Animal health, care, and management

The collection and testing of urine and fecal samples were conducted before and after the feeding trial to ensure that the animals remained healthy and free from health issues. Fecal and urine samples were analyzed at the Biosafety and Environment Section (BES) laboratory of PCC. All animals were given a 7-day adjustment period before the actual data collection. During this period, the animals were weighed, dewormed with Triclabendazole, and injected with Vitamin A, D, and E. Throughout the experiment, each animal was housed in an individual pen and provided with ad libitum access to clean and fresh drinking water.

Ethical approval

All experimental procedures, including animal maintenance and sample collection, were conducted following the guidelines of the ethical committee at the Philippine Carabao Center National Headquarters and Gene Pool with research code AN20002-ROG and as describe by the Animal Research: Reporting of In Vivo Experiments (ARRIVE) (Percie du Sert et al., 2020).

Collection of samples

Feed offered and refusal by each animal was collected and weighed daily. Approximately 200g samples of the collected feed were dried and ground for proximate analysis.

Cost and return analysis of MNLB production

The cost of producing MNLB was included to demonstrate the economic benefits of the products for dairy farmers as an alternative to commercially available mineral lick. The cost of the block was calculated based on 2021 prices of feed ingredients used.

Statistical analysis

The statistical analysis of our research involved performing appropriate tests to determine the significance of the differences in dependent variable(s) such as weight gain. We conducted tests for assumptions of normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test). One-way ANOVA was used for normally distributed data, while the Kruskal-Wallis rank sum test was used for non-normally distributed data. Tukey's test was used for post-hoc comparisons following a significant one-way ANOVA, and the Bonferroni correction was applied for post-hoc comparisons following the Kruskal-Wallis test (P=0.05 and 0.1).

RESULTS AND DISCUSSION

Nutritional composition of MNLB

Laboratory analysis revealed that the MNLB used in the study contains 85.32% DM and 29.83% CP, surpassing the 17.2-17.6% CP reported by Muhammed (2016). The inclusion of ipil-ipil leaves and a minimal amount of urea contributed to the increased protein content (Sankar et al., 2020), enhancing the overall nutritional value of MNLB. This suggests its potential as a valuable protein source for ruminants in areas with limited access to high-quality feeds and forages. On the other hand, Table 2 demonstrates that the developed MNLB had higher levels of sodium (5,487.76 mg/kg), calcium (49,968.77 mg/kg), selenium (265.81mg/kg), phosphorus (0.88 %), and iodine (3.68 %) compared to commercially available mineral blocks. This is attributed to the mineral premix, Di-calcium phosphate, and salt incorporated into MNLB, which includes essential macro and micro minerals like Ca, P, Na, Fe, Cu, Mn, Zn, I, Se, and Co (Ben Salem, 2007). Supplementation of MNLB could provide animals with their daily mineral requirements, helping to optimize productivity and reproductive efficiency, especially in regions where forage quality is poor and supply is inadequate (Bhanderi et al., 2016).

Table 2 - Mineral analysis and Crude Protein availability of MNLB

Components	Method(s)	MNLB	Commercial mineral block
Manganese, mg/kg	Atomic Absorption Spectrometry	73.51	200
Sodium, mg/kg		5,487.76	3800
Copper, mg/kg		16.35	300
Zinc, mg/kg		43.10	300
Selenium, mg/kg		265.81	10
Calcium, mg/kg		49,968.77	250
Cobalt, mg/kg		1.48	50
magnesium, mg/kg		2,359.43	5000
Phosphorus, %	Colorimetry	0.88	
Iodine, %	Lodometry	3.68	1.5
Crude Protein %		29.83	0

* MNLB: Multi-Nutrient Block

Palatability test and evaluation of the effect of MNLB on growth performance of growing buffaloes

Palatability and acceptance trial

The MNLB formulation used in this study exhibited high palatability and acceptance among buffaloes. All animals readily consumed the blocks, demonstrating frequent licking behavior during the initial week until complete consumption. This positive response suggests that the MNLB's unique composition effectively catered to the buffaloes' nutritional and sensory preferences. The average daily consumption of 192.10 g/head/day over a 30-day period (5, 640 g/animal/day) presented in Table 3 further underscores the MNLB's appeal. This consumption rates indicates that the blocks were palatable to the buffaloes. Several factors likely contributed to the MNLB's palatability and acceptance. The inclusion of molasses, renowned for its sweet taste and pleasant aroma (Upadhyay et al., 2018), likely played a significant role in enhancing the blocks' appeal. Additionally, minerals provided essential nutrients and contributed to the overall nutritional balance of the MNLB. Salt, a common component in mineral blocks, served both as a flavor enhancer and a preservative (Ben Salem et al., 2007; Mohammed et al., 2007). By incorporating salt into the formulation, the MNLB's shelf life was potentially extended, ensuring consistent quality and palatability over time. Urea, another key component, is known for its ability to improve feed digestibility and intake. By providing non-protein nitrogen, urea can supplement protein sources in the diet, potentially enhancing the overall nutritional value of the MNLB (Makkar, 2007).

Table 3. Average MNLB intake and ADG of growing animals fed with MNLB for palatability test.

Parameters	Value
Total consumed (g)	5,640.00
Average daily intake (g)	192.10

* MNLB: Multi-Nutrient Block, ADG: Average Daily Gain

Table 4 - Average dry matter intake (DMI) and crude Protein Intake (CPI) of animals offered with commercial mineral block, Blockmate and control.

Parameters \ Treatment	Control	Commercial mineral block	MNLB	P-Value
DMI Intake, kg				
1st month	10.2 ± 0.02^{b}	10.3 ± 0.04^{b}	10.6 ± 0.05^{a}	<0.001**
2nd month	9.33 ± 0.01^{b}	9.31 ± 0.01^{b}	9.58 ± 0.04^{a}	<0.001**
3rd month	9.12 ± 0.05^{c}	9.22 ± 0.01^{b}	9.47 ± 0.03^{a}	0.001**
Average daily DMI	9.56 ± 0.02^{b}	9.59 ± 0.01^{b}	9.88 ± 0.03^{a}	<0.001**
CPI Intake, kg				
1st month	881 ± 1.23^{b}	883 ± 2.43^{b}	906 ± 3.37^{a}	<0.001**
2nd month	1023 ± 1.29^{b}	1020 ± 0.65^{b}	1040 ± 3.33^{a}	0.003**
3rd month	1046 ± 0.73^{b}	1049 ± 0.43^{b}	1071 ±2.46^{a}	0.002**
Average daily CPI	983 ± 0.63^{b}	984 ± 0.84^{b}	1006 ± 2.58^{a}	<0.001**

* Note: Values are presented as mean ± standard error (Mean ± SE). Different superscript letters (a, b, c) indicate significant differences between treatment means (P < 0.05). Highly significant differences (P < 0.01) are denoted by **, and significant differences by (P < 0.05). MNLB: Multi-Nutrient Lick Block.

Dry matter intake (DMI) and crude protein intake (CPI)

MNLB supplementation significantly influenced both DM intake and CP intake among the groups (Table 4). Statistical analyses revealed significant differences (P<0.05) between treatments for both DMI and CPI over the three-month feeding trial. These findings are similar to those of Bohra et al. (2012) in Rathi cattle, where DMI and CPI in control and supplemented groups were 2.93 and 3.96 kg, and 97 and 274 g per animal per day, respectively. The availability of molasses, urea, and minerals as source of energy, protein, and minerals through urea molasses multi-nutrient block optimizes rumen fermentation and consequently increases utilization of crop residues (Meel et al., 2015).

Animals receiving the MNLB (Treatment 3) consistently consumed significantly higher amounts of both DMI and CPI compared to the other groups (Treatments 1 and 2). This trend persisted throughout the feeding trial, suggesting that the MNLB formulation was more palatable or provided additional nutritional benefits that encouraged increased consumption. In contrast, animals in the control group (Treatment 1) and those offered the commercial mineral block (Treatment 2) exhibited lower DMI and CPI, particularly during the early stages of the trial. These results indicate that the mineral block supplementation, while not as effective as MNLB, did provide some nutritional benefits that may have influenced feed intake to a certain extent. The results of this study suggest that the MNLB formulation developed in this research is more palatable and nutritious than the commercial mineral block. This is likely due to the unique combination of ingredients and nutrients included in the MNLB, which may have enhanced its appeal for the animals. Farmers and animal caretakers should carefully consider these factors when selecting feed blocks to ensure optimal nutrient intake and animal health. By choosing a feed block that is both palatable and provides adequate nutrients, they can improve animal performance, productivity, and overall well-being.

Evaluation of the effect of MNLB on growth performance of growing buffaloes

MNLB supplementation did not result in significant differences in total weight gain or average daily gain (ADG) compared to the other two groups (Table 5). This finding aligns with observations in cattle (Nurwahidah et al., 2016, Windsor et al., 2020), cows (Suharyono, 2014), and Mecheri ram lambs (Muralidharan et al., 2016), which also showed no significant differences in body weight. Although the results in Table 5 for total weight gain and ADG were not statistically significant, animals in T3 showed the highest weight gain and ADG. This is particularly important for fattening animals, as it allows them to reach target weights in a shorter period. According to Mengistul and Hasen (2018), MNLB supplementation has a significant positive effect on rumen microbial growth, feed intake, digestibility, live weight, and growth rate. However, these results contrast with the findings of Hatungimana and Ndolisha (2015), who observed that groups supplemented with blocks containing 7% urea exhibited higher growth performance than the control group. This discrepancy may be attributed to several factors, including differences in the specific mineral block composition, animal breed, environmental conditions, and experimental methodologies (Fesaha and Urge, 2014, Li et al., 2014, Dharan et al., 2015).

For feed conversion efficiency (Table 5), there were no significant differences between the groups. However, numerically, MNLB supplementation reduced the amount of feed required per kg body weight gain by 7-8 %, similar to the findings of Barque et al. (2008) in male buffalo calves, where feed required per kg gain of body weight gain decreased from 2.97 to 2.87. While the MNLB did not significantly impact growth performance in this study, it is important to note that other factors, such as overall feed intake, nutrient digestibility, and health status, may influence the animals' growth rates. Further research is needed to fully comprehend the potential benefits of MNLB supplementation on buffalo growth performance under various conditions.

Table 5 - Growth performance of animals offered with mineral block, MNLB and control (without blocks)

Parameters / Treatment	Control	Commercial mineral block	MNLB	P-Value
Age (months)	13.8 ± 1.11	13.6 ± 0.91	13.9 ± 0.79	0.969
Initial Weight (kg)	243 ± 5.26	248 ± 4.59	241 ±7.66	0.663
1st monthly Weight (kg)	281 ± 9.04	279 ± 7.12	271 ± 10.23	0.722
2nd monthly Weight (kg)	303 ± 8.36	306 ± 9.28	302 ± 9.91	0.952
Final Weight (kg)	321 ± 9.10	328 ± 8.26	329 ± 9.57	0.811
Total weight gain (kg)	78.3 ± 6.59	79.4 ± 4.30	87.8 ± 6.63	0.487
Average ADG (kg)	0.87 ± 0.07	0.88 ± 0.05	0.98 ± 0.07	0.487
Feed Conversion Efficiency (FCE)	0.71 (71 %)	0.72 (72 %)	0.79 (79 %)	0.735

* Note: Values are presented as mean ± standard error (Mean ± SE); no significant differences (P > 0.05) across treatments for any of the parameters. MNLB- Multi-Nutrient Lick Block

The economic viability of MNLB

Cost to produce MNLB

The MNLB formulation presented in this study demonstrates significant economic advantages over commercially available mineral blocks. Based on prevailing market prices, the cost of producing 100 kilograms of MNLB mixture (20 pieces) was calculated to be 5.67 USD (Table 6), which translates to a suggested retail price of 6.86 USD per block (Table 7). This price is substantially lower than the 14.71 USD (Table 7) cost of commercially available mineral blocks, making the MNLB a highly affordable option for smallholder farmers. The MNLB's affordability is further enhanced by its reliance on locally available resources, which can reduce transportation and handling costs. This aligns with the findings of Muhammed et al. (2016) and Agada et al. (2018), who also emphasized the economic benefits of producing multi-nutrient blocks using locally sourced materials. In addition to its lower cost, the MNLB offers superior nutritional value. As shown in Table 2, the MNLB contains higher levels of Na, Ca, Se, P, and I, compared to commercially available mineral blocks. This enhanced nutritional profile makes the MNLB a more economical and beneficial choice for livestock producers, as it can potentially improve animal health, growth, and reproductive performance. Thus, the MNLB represents a promising and economically viable option for smallholder farmers in the Philippines. Its affordability, coupled with its superior nutritional composition, makes it a valuable tool for improving livestock productivity and profitability.

Table 6 - Cost to produce MNLB based on 2021 price of ingredients.

Supplies and materials / MNLB Technology	Quantity	Unit cost (USD)	Unit	Total cost (USD)
Pail	1.00	4.90	USD/pc	4.90
Shovel	1.00	7.84	USD/pc	7.84
Plastic drum (200 liters capacity) depreciation cost 12 months life span)	1.00	1.96	USD/pc	1.96
Molasses	37.00	0.73	USD/kilo	26.85
Cement	10.00	0.20	USD/kilo	1.96
Rice bran	25.00	0.53	USD/kilo	13.24
Mineral mix	1.00	1.37	USD/kilo	1.37
Salt	1.00	0.20	USD/kilo	0.20
Urea	6.00	0.98	USD/bag	5.88
Ipil-ipil leaves	10.00	0.29	USD/kilo	2.94
Di-calcium phosphate	3.00	1.47	USD/kilo	4.41
Professional services				
Laborer/ helper	2.00	7.84	USD/day	15.69
Other expenses				
Water	1.00	0.33	USD/day	0.33
Fabricated molder	2.00	1.96	USD/pc	3.92
Plastic tray	7.00	1.96	USD/pc	13.73
Drying rack (steel 5 layer)depreciation cost (12 months)	1.00	8.17	USD/month	8.17
Total Expenses	-	-	-	113.40
Cost of producing per block	20.00	-	-	5.67
Gross sales (5 kg/block)	20.00	6.86	-	137.28
Net Income	-	-	-	23.88
ROI	-	-	-	21.06

Cost of ingredients may vary depending on the unit cost of raw materials; USD: United States Dollars

Table 7. Comparison on MNLB over commercially available mineral lick/blocks

Blocks	Wt./block (kg)	Price/block (SRP)	Composition
MNLB	5	6.86 USD	With crude protein
Commercial mineral block	5	14.71 USD	Without crude protein

***Note:** The price of the MNLB was derived from the calculation shown in Table 6. The price of the commercial block reflects the suggested retail price (SRP) at the time of the study; USD- United States Dollars

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, the locally produced multi-nutrient block (MNLB) demonstrated superior nutritional value, containing 85.32% dry matter (DM) and 20.50% crude protein (CP), higher than the 17.2 to 17.6% CP in commercial products. Enhanced by ipil-ipil leaves and urea, the MNLB also surpassed commercial mineral blocks in essential minerals, including sodium (5,487.76 ppm) and calcium (49,968.77 ppm). The buffaloes' high acceptance and increased dry matter intake (9.88 kg) and crude protein intake (1,006 g) reflect the MNLB's palatability and effectiveness. Although it did not statistically show impact on growth performance, the MNLB offers substantial cost savings at 6.86 USD per 5 kg block, compared to 14.71 USD for commercial alternatives. This makes the MNLB an affordable, nutrient-rich feed supplement, particularly beneficial for smallholder farmers in resource-limited settings. Given the positive effects of multi-nutrient block on nutrient intake, further research is recommended to assess its impact on different buffalo groups, such as fattening animals, growing bulls, and lactating buffaloes. Additionally, conducting feeding trials in areas prone to dry seasons would help evaluate the MNLB's effectiveness in addressing feed scarcity during these periods.

DECLARATIONS

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Authors Contribution

The first author, Phoebe Lyndia T. Llantada, contributed to the refinement of the proposal, led the experimental design and execution, conducted data analysis, and played a significant role in manuscript preparation and refinement. The second author, Charity I. Castillo, assisted with the experimental execution, data analysis, manuscript writing and refinement. The third and fourth authors, Mary Rose D. Uy-De Guia and Reynald D. Amido, respectively, contributed to the conceptualization of the research study, submitted the proposal, and drafted the manuscript. The fifth and sixth authors, Vienna Kristel A. Grospe and Psalm Joseph F. Lavarias, respectively, were instrumental in data collection and laboratory analysis. The seventh author, Edwin G. Gonzales, contributed to laboratory analysis. The eighth author, Arnel N. del Barrio, conceptualized the conduct of the study.

Competing interests

The authors declare that they have no competing financial interests, personal relationships or other affiliations that could have appeared to influence the work reported in this paper.

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