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Alternativa de bloques multinutricionales a base de subproductos agroindustriales para la suplementación de ganado lechero en pastoreo en la provincia del Alto Amazonas, Loreto

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Abstract

Multi-nutrient blocks (MNB) made from agro-industrial by-products can provide an affordable alternative to replace traditional corn and soybean meal inputs with an energy, protein balance in animal feed. The objective of this study was to evaluate the effect of BMN made from agro-industrial by-products on the productive performance of dairy cattle under an extensive system. Twelve Girolando cows were used, distributed in four groups of three animals for 30 days (10 days of adaptation and 20 days of evaluation). A completely randomized design (CRD) was used for 4 treatments: T_0 control group consisted of consumption of Brachiaria grass (*B. brizantha*) and mineral salts. The animals in groups T_1, T_2 and T_3 were supplemented with blocks made in equal levels with molasses, urea, mineral salts, common salt, lime, cement, palm oil and differentiated T_2 and T_3 with 30 % coconut cake and 30 % palm kernel meal, respectively. Daily milk production (g/animal/day), milk composition (protein, fat, lactose, total solids, %), and block matter intake (g/animal/day) were measured. The total dry matter intake (g/animal/day) in T_1 821, T_2 804 and T_3 776 of the blocks, improved milk production by determining significant differences between the groups ($p<0.01$), evidencing a 30% increase in milk production. The results obtained in this study with BMN supplementation had a positive effect on milk production parameters, which could be attributed to the higher energy and nitrogen intake when used as a feed supplement for grazing cows

Resumen

Los bloques multinutricionales (BMN) elaborados a partir de subproductos agroindustriales pueden brindar una alternativa asequible para reemplazar insumos tradicionales de maíz y torta de soya, con un balance energético, proteico en la alimentación animal. El objetivo de este estudio fue evaluar el efecto de BMN elaborados con subproductos agroindustriales sobre el comportamiento productivo de ganado lechero bajo un sistema extensivo. Se utilizaron 12 vacas de raza Girolando distribuidos en 4 grupos de 3 animales durante 30 días (10 días de adaptación y 20 días de evaluación). Se utilizó un diseño completamente al azar (DCA) para 4 tratamientos: El grupo control T_0 consistió en el consumo de pasto Brachiaria (*B. brizantha*) y sales minerales. Los animales de los grupos T_1, T_2 y T_3 fueron suplementados con bloques elaborados en niveles iguales con melaza, urea, sales minerales, sal común, cal, cemento, aceite de palma y diferenciados T_2 y T_3 con 30 % de torta de coco y 30 % de harina de palmiste, respectivamente. Se midió la producción lechera diaria (g/animal/día), la composición de la leche (proteína, grasa, lactosa, sólidos totales, %) y el consumo de la materia de los bloques (g/animal/día). El consumo total de materia seca (g/animal/día) en T_1 821, T_2 804 y T_3 776 de los bloques, mejoró la producción láctea al determinarse diferencias significativas entre los grupos ($p<0.01$), evidenciándose un aumentó en un 30 % de la producción de leche. Los resultados obtenidos en este estudio con la suplementación de BMN tuvieron un efecto positivo en los parámetros de producción de leche, lo que podría atribuirse al mayor consumo de energía y nitrógeno cuando se usa como un suplemento alimenticio para vacas al pastoreo

Introduction

Dairy production in the tropical regions of Peru is one of the most important livestock activities, contributing significantly to the population's economy[1]. The livestock system is largely based on extensive, traditional management, solely on natural pastures and/or cultivated forages used to satisfy the nutritional needs of the region's livestock[2,3]. However, the quantity and quality of pasture varies throughout the year due to seasonal changes, affecting its availability during the dry season[4]. This problem generates insufficient nutritive value of the pasture, due to its high fiber and low protein content, limiting its consumption and digestibility[4,5].

Nevertheless, several supplementation strategies have been proposed for grazing[6,7]. Multinutritional blocks (MNB) are an excellent alternative as a feed supplement to complement the nutrients needed by cattle when pasture availability is scarce[8]. Initially, MNB contain urea, binders, salt, vitamins and minerals to meet non-protein nitrogen requirements in poor quality pastures, thus improving rumen microbial activity[9]. However, by using locally available agro-industrial by-products in the production of these blocks, it would be possible to increase livestock productivity given their nutritional value, availability and low market price[4].

The Peruvian Amazon has a great biodiversity of crops, including the production of 428000 t of oil palm and 9000 t of coconuts in the San Martin region[1]. Palm kernel expeller (PKE) and coconut cake (Cocos nucifera) (CC) are by-products of the oil industry, obtained through mechanical or solvent extraction processes[10]. Nevertheless, PKE plays an important role in ruminant nutrition, is inexpensive and locally available, and also meets the nutritional needs of livestock, providing protein, energy, vitamins and minerals[11-13]. Meanwhile, CC an ideal low-cost alternative by-product as a protein source for ruminant feeding[14,15]. Because of its nutritional value, availability and low market price, using these by-products in animal feed is a good option[4,14,16]. However, to our knowledge, there is little information on the effects of feeding dairy cattle with blocks made with by-products from local industry, such as PKE and CC. The objective of this study was to evaluate the effect of BMN made with agroindustrial by-products on the productive performance of dairy cattle under an extensive system.

Materials and methods

Study area. The study was conducted in the private cattle ranch "Rico Rico", located in the district of Yurimaguas, province of Alto Amazonas, Loreto region, Peru. Coordinates 03° 5' 5" South Latitude and 73° 1' 0" West Longitude, humid tropical climate, with a temperature between 27-29° C depending on the season, annual rainfall of 2115 mm per year[17].

Animals and treatment. Before starting the study, the animals were treated against endoparasites and vaccinated against clostridia. Twelve milking cows of the Girolando breed of dairy attitude provided by the private cattle ranch "Rico Rico" were selected; the cows were 5 years old and had an average of 2.5 calvings, with live weight 450 ± 41 kg and 205 ± 20 days of lactation. The animals evaluated grazed about 20 h per day in paddocks with pastures dominated by Brachiaria (*B. brizantha*) and milking was performed daily (04:00 am). The stocking rate ha-1 was 1.5. The cows were distributed uniformly in groups of 3 in 4 pens in the same lactation period. The BMN were-manually prepared in the field considering their nutritional value (Table 1). Nutrient characterization -

analyses were performed at the Laboratory of Animal Nutrition and Food Bromatology (LNABA) of the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas (UNTRM).

Table 1 Chemical composition of multinutritional blocks with agroindustrial byproducts and nutritional composition in dry matter

Ingredients	T_1 (%)	T_2 (%)	T_3 (%)
Ground corn	13.00	-	-
Soybean cake	10.00	-	-
Cotton pulp	2.50	-	-
Dust	4.50	-	-
Molasses*	39.50	39.50	39.50
Mineral salts	5.00	5.00	5.00
Common salt	5.00	5.00	5.00
Urea**	10.00	10.00	10.00
Cal	5.00	5.00	5.00
Cement	5.00	5.00	5.00
Palm kernel meal	-	-	30.00
Coconut cake	-	30.00	-
Palm oil	.50	.50	.50
Total	**100**	**100**	**100**
Nutritional composition			
Dry matter	84.45	82.05	82.85
Ethereal extract	2.71	5.57	6.34
Crude protein	38.18	37.23	35.54
Ashes	22.73	24.60	24.69
Starch	22.73	11.82	24.69
Sugar	11.04	12.92	14.94
NDF[1]	2.31	7.20	9.77
ADF[2]	11.84	5.42	15.44

[1] Neutral detergent fiber, [2] Acid detergent fiber.

Considering the preparation, solidification, molding and drying method proposed by Duressa & Bersissa.[18], the preparation and extraction of multiple food blocks took approximately 4 weeks. The blocks were 15 cm high, 20 cm in diameter and weighed an average of 1.5 kg.

The experiment was conducted under a completely randomized design (CRD) with 4 treatments and 3 replicates. An experimental period of 30 days was established, 10 days of adaptation and an evaluation phase of 20 days with inter-daily sampling. With 4 treatments (T): T_0 (under grazing with Brachiaria (*B. brizantha*) and mineral salts without supplementation) and T_1, T_2 and T_3 were supplemented with blocks made in equal levels with 39.50 % molasses, 10 % urea, 5 % mineral salts, 5 % common salt, 5 % lime, 5 % cement, 9.5 % palm oil and for treatments T_2 and T_3 with 30 % CC and 30 % PKE, respectively. They were administered to the animals individually during milking with an average duration of 30 min. The test animals received no nutritional supplements or diet other than the treatments described.

Parameters evaluated. Daily milk production (kg/animal/day), milk composition (protein, lactose, fat and total solids) were recorded with Lactoscan SPFP (Milkotronic, Bulgaria) and MilkoScan™ 7 RM (Foss®, Spain) devices. Daily BMN intake was calculated each day as the difference between the initial and final weight of the given blocks using a High Weight® TP9000 scale. Grass samples were collected from the paddocks according to the methodology of Carrere et al.[19]. The nutritional value of the Brachiaria (*B. brizantha*) diet is shown in Table 2. The relevant analyses were carried out at the LNABA of the UNTRM. The total nitrogen (TN) content to obtain the crude protein (CP) content[20], and the neutral detergent fiber (NDF), acid detergent fiber (FDA), and acid detergent lignin (ADL)[21] fractions, with the ANKOM® 220 equipment (ANKOM Technology, Macedonia NY-USA).

Statistical analysis. Analysis of variance (ANVA) was performed on DCA data collected with SAS Mean T values for milk quality and milk production were compared by Duncan's test, 95 % significance level.

Table 2 Nutritional composition of *B. brizantha* consumed by lactating cows (dry matter)

Características del forraje	*B. brizantha*
Composición nutricional	%
Materia seca	37.35
Extracto etéreo	2.30
Proteína bruta	5.60
Cenizas	8.90
Almidón	.00
Azúcar	.00
FDN[1]	74.52
FDA[2]	40.8

[1] Fibra detergente neutro, [2] Fibra detergente acida

Results

Dry matter intake (DM). The average BMN consumption during the evaluation period did not differ significantly (P>0.05) between T_1, T_2, T_3 Table 3. However, the average consumption presented a slight variation for T_1, T_2, T_3 between 821, 804 and 776 g/animal/day, respectively.

Milk production and composition. Table 4 the results of milk production and composition for the 4 experimental treatments in lactating cows. Significant difference (p<0.05) was observed between the group of cows that did not receive block supplementation (T_0) and those that received (T_1, T_2, T_3) averages (3.81) and (5.03, 4.55, 6.24) kg/animal/day, respectively, were obtained. Milk composition, animals supplemented with BMN presented higher protein content (%) compared to non-supplemented animals. The values of lactose % and total solids % did not differ between treatments.

Table 3 Dry matter intake of multinutritional blocks (g/animal/day) in cows at grazing

Variable	Treatment			Significance
	T_1	T_2	T_3	
BMN consumption (g/día)				
CMS	821.00[a]	804.00[a]	776.00[a]	NS

Standard error of the mean *= P<0.05, ** = P<0.01, NS = not significant, † P< 0.10.

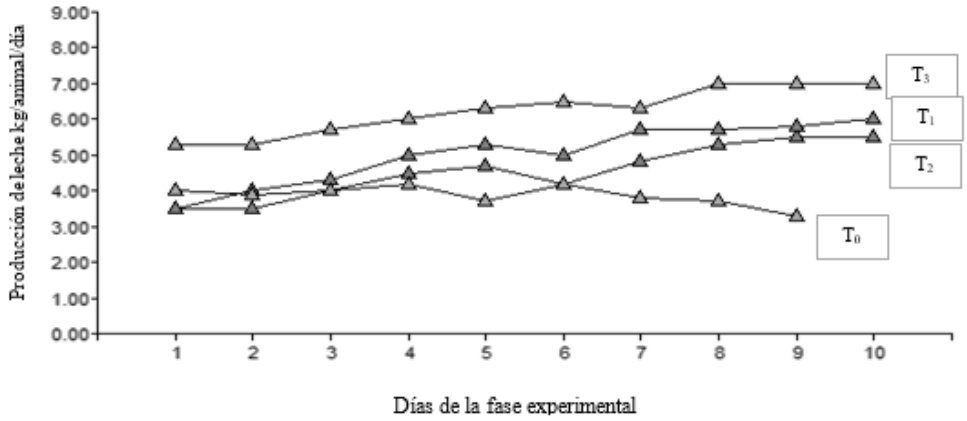
Table 4 Milk production (kg/animal/day), milk composition (%) between treatment in experimental cows

Variable	Treatment					Significance
	T_0	T_1	T_2	T_3	EEM[2]	
Milk production						
(kg/day)	3.81[c]	5.03[b]	4.55[b]	6.24[a]	0.15	**
Milk composition						
Total fat (%)	4.50	4.50	4.50	4.55	.90	NS
Total protein (%)	3.50[c]	3.60[ab]	3.65[a]	3.65[a]	.80	†
Lactose (%)	4.50	4.55	4.50	4.50	2.00	NS
Total solids (%)	12.85	12.85	12.85	12.86	3.20	NS

Standard error of the mean *= P<0.05, ** = P<0.01, NS = not significant, † P< 0.10

Figure 1, a 30 % increase in daily milk production in animals supplemented with BMN compared to animals consuming the control feed (T_0). However, during the experimental procedure, animals supplemented with T_3 treatment (BMN with 30 % PKE) presented a high difference of 5.55 to 6.24 kg in milk production, while T_1 and T_2 were similar from 4.00 to 5.03 and 3.9 to 4.55 kg, respectively.

Figure 1 Average milk production (kg/animal/day) over the experimental period between treatments



Discussion

In the present study, DM intake of BMN in animals was not affected for any treatment. Kawas et al.[22], suggested that BMN consumption is important to achieve the expected results of supplementation. In addition, the authors caution that consumption of blocks below 300 g/animal/day is unlikely to maximize consumption of the lower quality forages and, therefore, animal performance responses. Rodriguez Reyes et al.[2], when evaluating feeding strategies in dairy cows, reported an average value for DM intake through BMN of 700 and 897 g/animal/day. These intake values ensure a nutrient supply for rumen function and a sufficient amount of mineral intake to cover the daily needs of Obispo & Chicco.[23] cattle. In the present work, the average intake of the evaluated blocks was 821, 804 and 776 g/animal/day, considered optimal values for supplementation. This may be due to the positive effects of the properties of the ingredients used, acceptability, hardness and quality of the feed offered.

Milk production in cows supplemented with BMN showed a significant increase of 30 % in milk production. The average milk production of the experimental cows after 2 weeks of adaptation to BMN consumption until the end of the experiment increased from 5.2 to 6.24 kg/animal/day for the BMN treatments, while in the control group (T_0) it was observed that production declined from 3.9 to 3.81 kg/animal/day. In other studies, related to the use of BMN, Tekeba et al.[24] reported significant increases of 0.7 kg/animal/day representing 34 % in milk production in crossbred cows. Likewise, Rodriguez Reyes et al.[2] also reported that when BMN were added, cows increased their milk production from 3.40 to 7.87 kg, while the control group had a lower production of 2.1 to 5.92 kg/animal/day. More recent work by Gudiño-Escandón et al.[25] reported a significant increase in milk production among grazing cows fed BMN indicated an average increase in milk production of 0.84 kg/animal/day, with better results in the dry season.

Milk protein levels increased in the present study for animals supplemented with BMN. These results can

be attributed to the higher intake of rations with supplementation levels, and to the higher concentrations of non-fiber carbohydrates, which result in higher microbial rumen synthesis, contributing 40 to 80 % of the protein demand in the mammary gland[26]. However, no significant changes in milk fat or total solids were observed in this study, suggesting that the protein content in the milk composition of cows receiving BMN may not be biologically significant.

In the present study, we highlight the use of BMN elaborated from agroindustrial by-products as a dietary supplementation strategy for lactating cows, which can be very beneficial, since it resulted in a significant increase in milk production, as well as an improvement in productive behavior, rumen fermentation and increased consumption of pastures of low nutritional value. Finally, this positive response could be a practice to improve milk production. BMN are also easy to manufacture and supply to grazing cattle.

Source of financing

The company's own resources were used to carry out the research project.

Conflicts of interest

The authors of this research declare that they have no conflicts of interest in relation to the planning, execution and results of this work, which was carried out with the objective of obtaining information that will contribute to future research.

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Ethical considerations

In accordance with the procedures established by the Law for the Protection and Welfare of Animals, Law No. 30407 of Peru. In this research study, the welfare and integrity of the animals was guaranteed during the scientific, medical and zootechnical experiments.

Authors' contribution to the article

Edwaldo Villanueva-Pedraza, responsible for assisting in the planning, experimental management, detailed analysis of results, article writing and financing of the research. *Jeiner Alexander Villanueva-Guerrero*, helped design and conduct experiments with empirical design and statistical evaluation of all results. *Johnny Cueva-Valdivia*, contributed with the elaboration of the multinutritional blocks, statistical analysis and their interpretation. *Euclides Ticona-Chayña* and *Juan Ramon Calsin-Turpo*, contributed to the description and interpretation of the results. *Wendi Violeta Peñarrieta-Neira*, contributed to writing and analyzing the discussion.

Research limitations

No limits were presented during the experimental process or while writing the manuscript.

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