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**Nitrógeno no proteico de liberación controlada y Levadura
Saccharomyces cerevisiae en vacas lecheras**

**Controlled Release Non-Protein Nitrogen and *Saccharomyces cerevisiae* Yeast in
Dairy Cows**

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ABSTRACT

The objective was to analyze the non-protein controlled release Nitrogen and *Saccharomyces cerevisiae* Yeast in dairy cows from the Ecuadorian subtropics at the Hacienda "Lugmapata", Pallatanga Canton, Province of Chimborazo - Ecuador. A treatment was applied by means of a Complete Random Block design (CRBD). In the pre-treatment, for the milk protein content, there were no statistical differences ($P > 0.05$), obtaining a general average of 3.43%, while highly significant differences were recorded for the averages of the protein content during the treatment ($P < 0.01$), whose values from highest to lowest were 3.75; 3.74; 3.72 and 3.64% by using controlled release non-protein nitrogen plus *Saccharomyces cerevisiae* yeast treatments. A higher consumption of green forage and dry matter was determined in animals treated with controlled release non-protein Nitrogen plus *Saccharomyces cerevisiae* Yeast, which had an impact on milk yield, determining a higher production in the animals.

Descriptors: Dairy products; livestock; food production; food resources. (Words taken from the UNESCO Thesaurus).

INTRODUCTION

A fast time of technical-scientific development is experienced from a complex perspective (Tobón, et al, 2015), where the use of modern research methods in the field of animal feeding continuously contributes a multitude of new knowledge for the correct nutrition of the animals, especially, of the ruminants (Núñez-Torres, 2017). However, the synergy between theory and practice becomes hardly effective due to socioeconomic factors that alter the acquisition of knowledge and inputs of producers, making it difficult to raise animal production in quantity - quality (Lerdon, et al., 2015).

Considering the fundamentals of digestion and metabolism of ruminants, it makes it necessary to undertake experiences that provide information to improve the management of feeding in cattle (Arai, 2014). Feeding consultants and livestock breeders must accommodate their recommendations and proposed associations, taking into account the fundamentals of digestion, nutrition physiology to establish a relationship according to the type and level of animal production (Slama, et al., 2019).

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The efficient production of milk is usually a concern in dairy farmers to satisfy the market in terms of the quality of the product supplied (Loera & Banda, 2017), but the productive widespread growth has become a threat because the nutrients are not developed correctly, so supplementation is necessary to provide the daily weight gain for maintaining optimal animals coupled with reducing acidosis problems (Noro, et al., 2013).

In herds there are usually opportunities to increase the efficiency and performance of milk production; in most cases, it can be achieved through a simple method that mainly stimulates the quantity and quality of milk, which consists in improving the rumen function. Regardless of the digestive system, the improved rumen activity will increase the yield to the level closest to the total potential of the animal (Cardona-Iglesias, et al., 2017). Considering that the nitrogen that comes from food is found in two forms, either as part of the protein molecule (dietary protein) or as non-protein nitrogen (NNP) (Galindo, et al., 2017). Depending on the type of protein, a certain amount is degraded by the action of the rumen microflora, while the non-degradable fraction constitutes the bypass protein. NNP is highly soluble and completely hydrolyzed in the rumen and transformed to ammonia, as long as it does not exceed the capacity of the rumen microflora to convert more NNP into a microbial protein (Raabis, S., & Cersosimo, 2019).

On the other hand, the yeast compounds *Saccharomyces cerevisiae* stimulate lactic acid utilizing micro-organisms, which helps to control rumen pH, maintain its optimal level, as well as improve its fiber degradation, which means that the same diet can release more energy for the cow, simply, because of a more favorable rumen environment (Jansen, et al., 2017). For the aforementioned, as the price of food increases, dairy farmers must work on the rumen environment to achieve a profitable solution, being pertinent that the dairy sector take advantage of the unique digestive characteristics of ruminants, pursuing high efficiency in the conversion of food into milk and also an improvement in animal health (Fischer, et al., 2019).

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Based on the above, the objective of this research is: to analyze the non-protein controlled release Nitrogen and *Saccharomyces cerevisiae* Yeast in dairy cows from the Ecuadorian subtropics in the “Lugmapata” Farm, of the Pallatanga Canton, Chimborazo Province – Ecuador.

METHOD

Geographical and spatial space

The investigation was carried out at the Hacienda "Lugmapata", Pallatanga Canton, Province of Chimborazo. The duration of the experiment was 15 days for adapting the animals, 90 days for evaluating the products used, and 15 days for tabulating the data and presenting the final document. The experimental units were made up of lactating cows from the second to the fourth calving of the Brown Swiss breed, weighing between 384.00 and 437.00 kg, which were divided into four blocks of six animals, requiring a total of 24 animals.

Treatment

Four treatments were evaluated in Brown Swiss cows, being operationalized by direct grazing and supplementary diet of 150 g of molasses plus 100 g / a / d of mineral salt, where the biotechnological products were provided, such as: T1: Urea (50 g / d). T2: Non-protein controlled release nitrogen (60g / d), T3: *Saccharomyces cerevisiae* yeast (10 g / d) and T4: Non-protein controlled release nitrogen (60g / day) plus *Saccharomyces cerevisiae* yeast (10g / day) as a supplemental diet additive.

Experimental design

Treatment was applied by Randomized Complete Blocks Design (RCBD).

Experimental procedure

Prophylactic work was carried out with quaternary ammonium in the facilities; the bovine units had 15 days for their respective adaptation and were wormed with 10% Albendazole. Using 24 lactating cows from second to fourth calving of the Brown Swiss breed, with weights between 384.0 and 437.0 kg, they were divided into four blocks of

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six animals. It should be noted that each animal represented an experimental unit. The four experimental treatments received natural feeding to direct grazing in pastures of honey grass (*Paspalum dilatatum*), in addition to the supplements that were supplied in a mixture with 150g / d and mineral salt 100g / d.

The facilities consisted of a linear feeder, where the supplements were provided; these were weighed in individual bags and stored to facilitate their administration. Carrying out the proper sanitary measures on a daily basis, the data of the variables were recorded from the beginning of the investigation in the aforementioned treatments. For the determination of feed consumption, the forage production and the waste of the pasture due to the grazing effect were measured. This technique was applied by using a quadrant developed fortnightly during the trial.

Milk production was recorded in the morning and in the afternoon (2 milkings), for the determination of fat and protein, milk samples were taken and sent to the laboratory at the beginning and during the treatment for the day 80. For the determination of Protein Nitrogen in the Plasma, blood samples were taken from the tail vein of each one of the animals, by means of the use of a vacutainer tube, to send them to the laboratory after centrifugation.

RESULTS AND DISCUSSION

At the end of the evaluation of the cows' weights, highly significant differences ($P < 0.01$) were evidenced with non-protein controlled release Nitrogen plus *Saccharomyces cerevisiae* Yeast. Such differences are the following: 427.33 Kg was the highest average obtained in the cows; being the average range between 422.50 and 422.83 Kg, while the lower average of the final weight recorded was 418.67 Kg, when using Urea.

The final weight determined by using non-protein controlled release nitrogen plus Yeast *Saccharomyces cerevisiae*, was favored by the beneficial effect of yeasts and non-protein nitrogen, inciting microorganisms generators of lactic acid to contribute to balance the rumen pH, keeping it at its optimum level. On the other hand, the

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Enhancement of fiber degradation as an action of fiber-digesting bacteria is quickly diminished in the case of low rumen pH, which means that more energy is released for the cow, simply by a more favorable rumen environment, which agrees with (Hartinger, et al., 2018).

Productive behavior of Brown Swiss dairy cows, faced with the effect of the use of two biotechnological products, controlled release non-protein nitrogen and *Saccharomyces cerevisiae* yeast.

Weight gain

Statistical differences were recorded in weight gain: 21.67 Kg after using controlled release non-protein nitrogen plus *Saccharomyces cerevisiae* yeast; also, an average of 18.5 and 16.0K with the treatments Controlled release non-protein nitrogen and *Saccharomyces cerevisiae* yeast, respectively. Finally, when using urea, a weight of 13.33 kg was achieved.

The inclusion of NNP resulted in growth bacterial increase together with a significant improvement in the digestibility of organic matter and fiber. High concentrations of volatile fatty acids (VFA) were also recorded as a result of a more intense microbial activity, which influences not only the production but also the improvement of the animal's meat status or body condition.

Green Forage Consumption

The consumption of green forage in the cows presented statistical differences ($P < 0.01$). The highest consumption was presented by the cows with controlled release non-protein Nitrogen plus *Saccharomyces cerevisiae* Yeast (3727.50Kg), followed by the consumption of green forage of the cows with Non-protein controlled release nitrogen with 3705.17Kg, finally, the cows treated with Urea and *Saccharomyces cerevisiae* yeast presented lower consumption values with 3685.83 and 3689.83 respectively.

Dry Matter Consumption

The dry matter consumption differed statistically ($P < 0.01$) between the treatments, so the animals with non-protein controlled release Nitrogen plus *Saccharomyces cerevisiae*

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yeast consumed the highest amount of dry matter, followed by those that used controlled release non-protein Nitrogen, *Saccharomyces cerevisiae* Yeast, and Urea in their order from highest to lowest. It was established a consumption of 931.88; 926.30; 922.48 and 921.48 Kg.

These results were related to what had been determined in recent research, where significant increases even greater than 11% in fiber digestibility (NDF) had been found with diets added with yeast offered at noon (Ison, et al., 2020).

On the other hand, regarding these results, it has been necessary to highlight that yeast operates in the same way both in the rumen of fattening cattle as in that of dairy cows. However, overall feeding schedules and management were different. A response to yeast cultures added to dairy cattle diets could be expected at 30 to 60 days (Yada, et al., 2017).

Milk production / cow / day

Milk production was affected by the effect of the inclusion of biotechnological products in the feeding of the cows, thus the averages of milk production per cow and per day presented statistical differences ($P < 0.01$), between the treatments, registering a higher milk production in the cows treated with controlled release non- protein Nitrogen plus *Saccharomyces cerevisiae* yeast with an average of 9.00 liters, followed by treatments in which controlled release non-protein nitrogen, *Saccharomyces cerevisiae* yeast and Urea were used with averages of 7.57; 7.00 and 6.37 liters of milk / cow / day.

These results were based on what was described by (Cremonesi, et al., 2018), who indicated that increased production of microbial protein could increase milk production and its components in dairy cattle and improve weight in meat animals. Optigen was a revolutionary ingredient that gave nutritionists flexibility in formulating diets, while improving the conservation and utilization of nitrogen by the animal.

Grease

The fat content in milk prior to the treatments did not present statistical differences ($P > 0.05$), registering a general average of 3.26%, while the fat content in milk presented highly significant differences ($P < 0.01$), reporting the highest value for the milk of the

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cows with controlled release non-protein nitrogen plus *Saccharomyces cerevisiae* yeast with 3.67%; meanwhile the fat content of the milk of the cows treated with controlled release non-protein nitrogen, *Saccharomyces cerevisiae* yeast and Urea were 3.63; 3.55 and 3.32% in their order. The results obtained were in accordance with (Underwood, et al., 2018), who indicated that by obtaining a better rumen efficiency, the production of milk and its components were improved when using these biotechnological compounds.

Protein

For the protein content in milk, there were no statistical differences ($P > 0.05$), obtaining a general average of 3.43%. Besides, highly significant differences were recorded for the averages of the protein content during the treatment ($P < 0.01$), whose values from highest to lowest were 3.75; 3.74; 3.72 and 3.64%. For the treatments, Non-protein controlled release nitrogen plus Yeast *Saccharomyces cerevisiae*, Non-protein nitrogen controlled release, Yeast *Saccharomyces cerevisiae* and Urea were respectively used. The results obtained were in accordance with (Underwood, et al., 2018), who stated that when using yeast and NNP, there was greater production of microbial protein, since Optigen had 41% of N that represented 256% of Crude Protein.

Non Protein Nitrogen

There were no statistical differences ($P > 0.05$) in the non-protein nitrogen content of the pretreatment plasma, registering values of 15.02, 15.04; 15.08 and 15.09 mg / dL for cows treated with *Saccharomyces cerevisiae* yeast, Urea treatments, controlled release non-protein nitrogen treatments and controlled release non-protein nitrogen treatments plus *Saccharomyces cerevisiae* yeast respectively. While during treatment, non-protein nitrogen in plasma presented highly significant differences ($P < 0.01$), with averages of 16.08; 22.30; 22.64 and 24.00 mg / dL for cows treated with *Saccharomyces cerevisiae* yeast treatments, controlled release non-protein nitrogen treatments plus *Saccharomyces cerevisiae* yeast, controlled release non-protein nitrogen treatments and Urea respectively.

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Likewise, these results were related to what was determined by (Underwood, et al., 2018), who stated that according to in situ technique, 6.30% of the NNP in Optigen was immediately available and the fractional rate of disappearance was 0.24 / hour, which allowed a rate of passage regulated by the size and density of the particles and, on the other hand, did not increase the urea concentration in the milk.

These results agreed with (Velásquez & Alfonso, 2011), who studied the effect of supplementation with controlled release non-protein nitrogen on the levels of urea nitrogen in milk (NUL) in a Holstein herded in Tropic Alto, identifying significant differences for NUL ($p < 0.05$) and percentage of fat in milk ($p < 0.01$), however, it did not determine significant differences in percentage of protein in milk.

The findings of this study indicated the advantage of supplying a controlled release non-protein nitrogen source over plasma nitrogen levels in early lactation dairy cows, which, unlike the urea commonly supplied to cattle, presented representative advantages. The inclusion of controlled release non-protein nitrogen treatments plus *Saccharomyces cerevisiae* yeast in the feed of Brown Swiss cows, reported the highest Benefit / Cost ratio with USD 1.26, which indicated that for every dollar invested a net profit of USD 0.26 was obtained; while for the controlled release non-protein Nitrogen treatments, Yeast *Saccharomyces cerevisiae* and Urea treatments, the Benefit / Cost ratio was \$ 1.21; \$ 1.20 and \$ 1.18 respectively.

CONCLUSION

Cows treated with controlled release non-protein Nitrogen plus *Saccharomyces cerevisiae* Yeast obtained the best final weight average with 427.33 Kg and a weight gain of 21.67 Kg as a result of improved rumen activity and availability of non-protein nitrogen in the diet, which was exploited in the form of microbial protein.

A higher consumption of green forage and dry matter was determined in animals treated with controlled release non-protein Nitrogen plus *Saccharomyces cerevisiae* Yeast, which had an impact on milk yield, determining a higher production in animals treated with these two compounds, registering a production of 9 liters / cow / day.

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In the evaluation of the fat and protein content of the milk during the treatment, the best averages were determined in the cows treated with non-protein controlled release Nitrogen plus *Saccharomyces cerevisiae* Yeast having 3.67% and 3.75% respectively. By using non-protein controlled release Nitrogen plus Yeast *Saccharomyces cerevisiae* in the feeding of Brown Swiss cows, a greater economic profitability is obtained, establishing a Benefit - Cost index of 1.26 USD, which means that for every dollar invested, a profit of 0.26 USD is earned.

FINANCING

Non- monetary

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REFERENCES

- Arai T. (2014). The Development of Animal Nutrition and Metabolism and the Challenges of Our Time. *Frontiers in veterinary science*, 1, 23. <https://doi.org/10.3389/fvets.2014.00023>
- Cardona-Iglesias, J, Mahecha-Ledesma, L, & Angulo-Arizala, J. (2017). Fodder shrubs and fatty acids: strategies to reduce enteric methane production in cattle. *Mesoamerican Agronomy*, 28(1), 273-288. <https://dx.doi.org/10.15517/am.v28i1.21466>
- Chen, X., Liu, X., Du, Y., Wang, B., Zhao, N., & Geng, Z. (2018). Green forage and fattening duration differentially modulate cecal microbiome of Wanxi white geese. *PloSone*, 13(9), e0204210. <https://doi.org/10.1371/journal.pone.0204210>

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- Cremonesi, P., Ceccarani, C., Curone, G., Severgnini, M., Pollera, C., Bronzo, V., Riva, F., Addis, MF, Filipe, J., Amadori, M., Trevisi, E., Vigo, D., Moroni, P. y Castiglioni, B. (2018). The diversity of the milk microbiome and the prevalence of the bacterial group in a comparison between healthy Holstein Friesian and Rendena cows. *PloS one*, 13 (10), e0205054. <https://doi.org/10.1371/journal.pone.0205054>
- Fischer, A. J., Villot, C., van Niekerk, J. K., Yohe, T. T., Renaud, D. L., & Steele, M. A. (2019). Invited Review: Nutritional regulation of gut function in dairy calves: From colostrum to weaning. *Applied Animal Science*, 35(5), 498–510. <https://doi.org/10.15232/aas.2019-01887>
- Galindo, J, Elías, A., Muñoz, E., Marrero, Y, González, N, & Sosa, A. (2017). Ruminant activators, general features and their advantages for feeding ruminants. *Cuban Journal of Agricultural Science*, 51(1), 11-23.
- Hartinger, T., Gresner, N., & Südekum, K. H. (2018). Does intra-ruminal nitrogen recycling waste valuable resources? A review of major players and their manipulation. *Journal of animal science and biotechnology*, 9, 33. <https://doi.org/10.1186/s40104-018-0249-x>
- INAMHI (2019). Key instant data. Available from <https://n9.cl/bpj6>
- Ison, K., Benvenuti, M. A., Mayer, D. G., Quigley, S., & Barber, D. G. (2020). Maximising Lucerne (*Medicago sativa*) Pasture Intake of Dairy Cows: 2-the Effect of Post-Grazing Pasture Height and Mixed Ration Level. *Animals: an open access journal from MDPI*, 10(5), 904. <https://doi.org/10.3390/ani10050904>
- Jansen, M., Bracher, J. M., Papapetridis, I., Verhoeven, M. D., de Bruijn, H., de Waal, P. P., van Maris, A., Klaassen, P., & Pronk, J. T. (2017). *Saccharomyces cerevisiae* strains for second-generation ethanol production: from academic exploration to industrial implementation. *FEMS yeast research*, 17(5), fox044. <https://doi.org/10.1093/femsyr/fox044>
- Lerdon, J, Bentjerodt, D, Carrillo, B, & Moreira, V. (2015). Economic analysis of 11 estates producing milk and meat in Los Ríos Region, Chile. *Idesia (Arica)*, 33(4), 89-104. <https://dx.doi.org/10.4067/S0718-34292015000400012>
- Loera, J, & Banda, J. (2017). Dairy industry in Mexico: parameters of the production of milk and supply of the internal market. *Journal of High Andean Research*, 19(4), 419-426. <https://dx.doi.org/10.18271/ria.2017.317>

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- Naah J. (2018). Investigating criteria for valuation of forage resources by local agro-pastoralists in West Africa: using quantitative ethnoecological approach. *Journal of ethnobiology and ethnomedicine*, 14(1), 62. <https://doi.org/10.1186/s13002-018-0261-4>
- Noro, M, Sepúlveda, P, Cárdenas, F, Chihuailaf, RH, &Wittwer, F. (2013). Dorsomedial rumenocentesis: a safe procedure for collecting ruminal fluid samples from grazing dairy cows. *Veterinary Medicine Archives*, 45(1), 25-31. <https://dx.doi.org/10.4067/S0301-732X2013000100005>
- Núñez-Torres, O. (2017). The costs of feeding in livestock production. *Journal of the SelvaAndina Animal Science*, 4(2), 93-94
- Raabis, S., Li, W., &Cersosimo, L. (2019). Effects and immune responses of probiotic treatment in ruminants. *Veterinary immunology and immunopathology*, 208, 58–66. <https://doi.org/10.1016/j.vetimm.2018.12.006>
- Salfer, I. J., Staley, C., Johnson, H. E., Sadowsky, M. J., & Stern, M. D. (2018). Comparisons of bacterial and archaeal communities in the rumen and a dual-flow continuous culture fermentation system using amplicon sequencing. *Journal of animal science*, 96(3), 1059–1072. <https://doi.org/10.1093/jas/skx056>
- Sentürklü, S., Landblom, D. G., Maddock, R., Petry, T., Wachenheim, C. J., & Paisley, S. I. (2018). Effect of yearling steer sequence grazing of perennial and annual forages in an integrated crop and livestock system on grazing performance, delayed feedlot entry, finishing performance, carcass measurements, and systems economics. *Journal of animal science*, 96(6), 2204–2218. <https://doi.org/10.1093/jas/sky150>
- Slama, J., Schedle, K., Wurzer, G. K., &Gierus, M. (2019). Physicochemical properties to support fibre characterization in monogastric animal nutrition. *Journal of the science of food and agriculture*, 99(8), 3895–3902. <https://doi.org/10.1002/jsfa.9612>
- Tobón, S Guzmán, C, Silvano-Hernández, J, & Cardona, S. (2015). Knowledge Society: Documentary Study from a Humanistic and Complex Perspective. *Paradigm*, 36(2), 7-36.
- Underwood, W. J., Blauwiekel, R., Delano, M. L., Gillesby, R., Mischler, S. A., &Schoell, A. (2015). Biology and Diseases of Ruminants (Sheep, Goats, and Cattle). *Laboratory Animal Medicine*, 623–694. <https://doi.org/10.1016/B978-0-12-409527-4.00015-8>

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- Velásquez, J, & Alfonso, L. (2011). Effect of controlled release non-protein nitrogen supplementation on NUL levels in a Holstein herd in the high tropics. Available from <https://n9.cl/s1rj>
- Yada, B., Brown-Guedira, G., Alajo, A., Ssemakula, G. N., Owusu-Mensah, E., Carey, E. E., Mwanga, R., & Yench, G. C. (2017). Genetic analysis and association of simple sequence repeat markers with storage root yield, dry matter, starch and β -carotene content in sweetpotato. *Breedingscience*, 67(2), 140–150. <https://doi.org/10.1270/jsbbs.16089>