Iraqi Journal of Market Research and Consumer Protection
(2025) 17(1): 267-273
DOI:
Karim & et al.,

المجلة العراقية لبحوث السوق
وحماية المستهلك

EFFECT OF DIETARY CALCIUM PROPIONATE SUPPLEMENTATION PRE- AND POST-PARTUM ON MILK YIELD PERSISTENCY OF IRAQI BUFFALOES AND SOME PRODUCTIVE TRAITS OF THEIR CALVES

Asraa M. Karim[1], Hussien K. Al-Waith[2], Saddam M. Al-Jubori[3]

[1]Researcher. Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. Israa.Jawad2101m@coagri.uobaghdad.edu.iq

[2]Assistant Professor Ph.D. Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq. hussien@coagri.uobaghdad.edu.iq

[3] Directorate of Agricultural Researches, Ministry of Agriculture, Iraq. ssalgbore@yahoo.com

Received 10/ 9/ 2023, Accepted 11/ 1/ 2024, Published 31/ 3/ 2025

ABSTRACT

This study was conducted to explore the effect of dietary calcium propionate (CP) supplementation on milk yield persistency (MYP) of Iraqi buffaloes and some productive traits of their calves (birth and weaning body weight, weight gain, and body measurements at birth and weaning). The experiment was executed at the Ruminant Research Station, Abu-Ghraib belonging to the Directorate of Animal Resources, Ministry of Agriculture from 10th May 2022 to 4th January 2023. Fifteen Iraqi dairy buffaloes; 6-7 years old were used and divided equally into three groups. The first group was regarded as the control group (T1) without any supplementation, whereas, 100 and 150 g of CP were added to the concentrate diet of the second (T2) and third (T3) groups. respectively for three experimental periods (7 hr. pre-partum and 24 hr. and 7 days' post-partum). The T2 group exhibited the higher ($P \leq 0.05$) MYP (1.153 ± 0.12 kg/kg) than T1 (0.831 ± 0.08 kg/kg) and T3 (0.819 ± 0.07 kg/kg) groups. On the other hand, higher ($P \leq 0.01$) calves' shoulder length was observed in T1 group (91.60 ± 1.88 cm) compared with T2 (81.60 ± 0.92 cm) and T3 (77.60 ± 2.85 cm) groups. In conclusion, adding of CP (100 g) to the concentrate diet of Iraqi buffaloes pre- and post-partum enhanced the MYP of Iraqi dairy buffaloes.

Keywords: Calcium propionate, Milk yield persistency, Buffaloes.

تأثير إضافة بروبيونات الكالسيوم الى العليقة قبل وبعد الولادة في المثابرة على انتاج الحليب لدى اناث الجاموس العراقي والصفات الإنتاجية لعجولها

أسراء مهند كريم [1] ، حسين خطاب الواعظ[2]، صدام محمد الجبوري[3]

[1] قسم الإنتاج الحيواني، كلية علوم الهندسة الزراعية، جامعة بغداد، بغداد، العراق Israa.Jawad2101m@coagri.uobaghdad.edu.iq

[2] أستاذ مساعد دكتور، قسم الإنتاج الحيواني، كلية علوم الهندسة الزراعية، جامعة بغداد، بغاد، العراق، hussien@coagri.uobaghdad,edu.iq

[3] باحث علمي، دائرة البحوث الزراعية، وزارة الزراعة، بغداد، العراق، ssalgbore@yahoo.com

الخلاصة

أجريت هذه الدراسة لبيان تأثير إضافة بروبيونات الكالسيوم الى العليقة قبل وبعد الولادة في المثابرة على انتاج الحليب لدى اناث الجاموس العراقي والصفات الإنتاجية لعجولها (وزن الجسم عند الولادة والفطام والزيادة الوزنية وقياسات الجسم عند الولادة والفطام). نفذت الدراسة في محطة بحوث المجترات التابعة لدائرة البحوث الزراعية في وزارة الزراعة للمدة من العاشر من شهر أيار 2022 ولغاية الرابع من شهر كانون الثاني 2023. استعملت في هذه الدراسة 15 من اناث الجاموس العراقي بعمر 6-7 سنوات، قسمت الى ثلاث مجاميع متساوية. عدت المجموعة الأولى بمثابة مجموعة سيطرة بدون اية إضافة، في الوقت الذي اضيف الى العليقة المركزة لإناث جاموس المجموعتين الثانية والثالثة 100 و150 غم من بروبيونات الكالسيوم على التوالي خلال ثلاث مدد (7 ساعات قبل الولادة و24 ساعة و7 أيام بعد الولادة).

أظهرت اناث المجموعة الثانية أعلى (P≤0.05) مثابرة على انتاج الحليب (1.153 ± 0.12 كغم / كغم) مقارنةً بالمجموعتين الاولى (0.831 ± 0.08 كغم / كغم) والثالثة (0.819 ± 0.07 كغم / كغم). من ناحيةٍ أخرى، سجلت المجموعة 1T اعلى (P≤0.01) طول لكتف العجول (91.60 ± 1.88 سم) مقارنةً بالمجموعتين 2T (81.60 ± 0.92 سم) و3T (77.60 ± 2.85 سم). يمكن الاستنتاج بان إضافة بروبيونات الكالسيوم (100 غم) الى العليقة المركزة قبل وبعد الولادة أدت الى تحسن المثابرة على انتاج الحليب لدى اناث الجاموس العراقي.

الكلمات المفتاحية: بروبيونات الكالسيوم، المثابرة على انتاج الحليب، اناث الجاموس.

INTRODUCTION

During the development of human civilization, milk, and its products played a major role in conferring many nutritional benefits due to its essential nutrients such as protein, fat, lactose, vitamins and minerals **(Khedkar *et al.*, 2016)**. The Economic Cooperation Organization (ECO) and the Food and Agriculture Organization (FAO) indicated that global milk production is dominated by cow's milk by 81%. Many types of livestock such as buffaloes, goats, and camels provide milk that can be converted into a number of milk products. The buffalo milk has a significant global contribution as it represents 15% of global milk production **(Mejares *et al.*, 2022)**.

A negative energy balance accompanied by early milking period is almost occurred due to insufficient dietary intake to meet the production requirements of nutrients for milk production **(Singh *et al.*, 2020)**. This negative energy balance in the early milking period reflects a large mobilization of body reserves associated with an increased incidence of metabolic disorders **(Ceciliani *et al.*, 2018)**. Hypocalcemia is a risk factor that reduces milk production and increases the incidence of dystocia, uterine prolapse, placental retention, ketosis, and mastitis **(Couto Serrenho *et al.*, 2021)**. Hypocalcemia plays causal roles in reducing dry matter intake, milk production, development of reproductive disorders, fertility problems, and infectious diseases **(Kara, 2013; EL-Delfi& Safi.,** 2023**)**. For dairy cattle breeding, dietary energy can be improved through fat supplementation or concentrate to reduce the negative energy balance, but excess fat supplementation inhibits the growth of microbes in the rumen, reduces the pH value of the rumen, and increases the rate of subclinical rumen acids **(Lin *et al.*, 2017)**. Therefore, studies and research tended to find a solution to this problem, and among these solutions is the addition of nutritional supplements, including calcium propionate **(Abdulkareem *et al.*, 2012; Wigati *et al.*, 2022)**.

Propionate is considered the primary glucose precursor in cattle milk and contributes to the synthesis of oxaloacetate **(Duplessis *et al.*, 2017)**. The propionate required for glucose synthesis in the liver decreases during the transition period due to the decrease in dry matter intake, so propionate can be taken orally in the form of calcium propionate **(Hernández *et al.*, 2009; Wala'a *et al.*, 2023)**. The transition period (three weeks pre- and post-calving) is of great value for the health, productive performance of dairy animals. Therefore, using of energy supplements during this period helps to overcome these problems **(Drackley, 1999)**. In ruminants, propionate acts as a source for energy and can also function independently as a metabolic determinant of nutritional status **(Harmon, 1992)**. CP is an organic salt formed from the reaction between calcium hydroxide and propionic acid with a molecular formula of 2 ($CH^{+3}CH_2COO$). Calcium propionate is soluble in water and can decompose in alkaline solution, but it acts as a microorganism in an acidic medium. It is synthesized mainly through the reaction between calcium salts and propionic acid **(Pongsavee, 2019)**. The CP is one of the most beneficial antimicrobial preservatives in the manufacture of fermented foods, especially in bread and fermented dairy products **(Sequeira *et al.*, 2017)**. It can be used as a feed preservative, growth promoter, intestinal microbiota enhancer, or appetite suppressant in animal feed **(Arrazola &Torrey, 2019)**. Orally administered CP as a nutritional supplement is an important tool to compensate for calcium deficiency, which can be significantly absorbed by the rumen and increase the concentration of ionized calcium in the blood **(Wilkens *et al.*, 2020).**

To the best of our knowledge, no previous data concerning the influence of dietary CP supplementation on milk yield persistency of Iraqi buffaloes and their calves' productive traits were investigated. Therefore, this study was undertaken to achieve these goals.

MATERIALS AND METHODS

Experimental animals and design

This study was executed at the Ruminant Research Station, Abu-Ghraib belonging to the Directorate of Animal Resources, Ministry of Agriculture from10th May 2022 to 4th January 2023, to investigate the influence of dietary CP supplementation on milk yield persistency MYP of Iraqi buffaloes and some productive traits of their calves (birth and weaning body weight, weight gain, and body measurements at birth and weaning). Fifteen Iraqi dairy buffaloes of 6-7 years old were used. Animals fed a concentrate diet consisting of ground barley (67%), yellow corn (10%), soybean meal (12%), cottonseed meal (8%), lime (2%) and salt (1%). The concentrated diet was introduced for two meals, morning and evening. Moreover, the buffaloes fed 15 kg of hay and 12 kg of alfalfa per animal daily according to what is available at the station.

The buffaloes were divided equally into three groups. The first group was regarded as control group (T1) without any supplementation, whereas, 100 and 150 g of CP were added to the concentrate diet of the second (T2) and third (T3) groups. respectively for three experimental periods (7 hr. pre-partum and 24 hr. and 7 days' post-partum). The calves were weaned at about 180 days of age.

Estimation of milk yield persistency

Milk yield persistency = milk yield in the second two months / the first two months.

Body measurements of calves

The calves' body measurements were performed pre-birth and post-weaning during the experimental period using a measuring tape. The body measurements involved:

1. Body height: the distance from the highest point of the animal's back near the neck (withers) to the end of the front legs.
2. Body length: the distance from the back between the cervical vertebrae and the coccygeal vertebrae.
3. Heart girth: measured by wrapping the measuring tape around the chest area directly behind the front legs.

Body weight and weight gain of calves

The birth weights at birth and weaning as well as the weight gain between birth and weaning were recorded using the following equation.

Animal weight = (body length x chest circumference x chest circumference) / 10900

STATISTICAL ANALYSIS

The statistical analysis system **(SAS, 2018)** was used to analyze the data to using a complete random design (CRD). Significant differences among means were compared using the Duncan multiple range test **(Duncan, 1955).** The statistical model was as follows:

$Yij = \mu + Ti + eij$

Where:

Yij: the observed j value of transaction i.

µ: the overall average for the studied trait.

Ti: effect of treatment i (0, 100, and 150g).

eij: the random error that is normally distributed with a mean of zero and a variance of $\sigma 2e$.

RESULTS AND DISCUSSION

Milk yield persistency

Table (1) revealed the effect of CP supplementation on MYP. The T2 group exhibited higher ($P \leq 0.05$) MYP (1.153 ± 0.12 kg/kg) than the T3 (0.819 ± 0.07 kg / kg) and T1 (0.831 ± 0.08 kg/kg) groups. **Yano *et al.* (1991)** indicated that calcium is one of the major minerals in ruminant's body. It plays an important role in neurotransmission and other metabolic activities, which may help improve animal health, improve metabolic processes in the body, and increase volatile fatty acids, which will reflect positively in increasing milk production for the longest possible period during lactation, this is the first study in Iraq dealing with the effect of dietary CP supplementation on the MYP in Iraqi buffaloes.

Table (1): Effect of dietary calcium propionate supplementation on milk yield persistency for Iraqi buffaloes (Mean ± SE).

Groups	Milk yield persistency (Kg/ Kg)
T1	0.831 ±0.08 b
T2	1.153 ±0.12 a
T3	0.819 ±0.07 b
Level of significance	P≤0.05
Expectation equation for the decline of milk production in the second two months over the first two months	**y^ = 1.424 + 0.881 **** **R^2= 0.61**

Means with different superscripts within the same column are significantly different ($P \leq 0.05$). T1: Control without CP supplementation; T2: 100 gm dietary CP supplementation; T3: 150 g dietary CP supplementation.

Body weight at birth, weaning and weight gain of buffalo calves

The differences among groups in either body weight at birth and weaning as well as weight gain of the calves lacked significance. However, these attributes tended to be higher in T1 than both T2 and T3 groups (Table 2). Calcium propionate plays an important role in the process of rumen development of calves and the growth and development of calves through the development of the rumen epithelium of calves during the period of converting calves from eating milk to eating green fodder to transform them into ruminants **(Zhang *et al.*, 2018)**, the increase in the number of bacteria in the rumen is also associated with volatile fatty acids, and calcium propionate is considered a nutritional supplement that helps in increasing the number of bacteria in the rumen and thus leads to the development of the animal and its increase in weight **(Liang *et al.*, 2016)**. In our experiment, the reason for no significant differences between the addition treatments and the control treatment may be attributed to the fact that the calves were not given calcium propionate, which led to the absence of significant differences.

Table (2): Effect of dietary calcium propionate supplementation on body weight at birth, weaning, and daily weight gain of the buffalo calves (Mean ± SE).

Groups	Weight at birth (Kg)	Weight at weaning (Kg)	Daily weight gain (g)
T1	47.60 ± 4.54	147.20 ± 18.69	99.60 ± 16.3
T2	44.80 ± 4.56	108.40 ± 27.89	63.60 ± 25.77
T3	42.00 ± 5.06	132.00 ± 17.46	90.00 ± 20.87
Level of significance	NS	NS	NS

NS: Non-significant. T1: Control without CP supplementation; T2: 100 gm dietary CP supplementation; T3: 150 g dietary CP supplementation.

Body measurements of the buffalo calves at birth

Higher ($P \leq 0.01$) shoulder length was observed in the T1-calves (91.60 ± 1.88 cm) compared with the T2 (81.60 ± 0.92 cm) and T3 (77.60 ± 2.85 cm) groups. However, the latter two groups were non-significantly different (Table 3). On the other hand, the differences among groups in both body length and heart girth of the buffalo calves lacked significance (Table 3). **Al-Qudsi *et al*. (2012)** indicated that the body measurements of cattle calves are of great importance for evaluating them in terms of the external shape of the animal to explain the type and the productive characteristics including meat and milk production. Other studies found the relationship between body measurements and milk yield of dairy cows and buffaloes, **Dhillod *etal*., (2017)** indicated that there is a relationship between body dimensions and milk production in Murrah buffalo.

Table (3): Effect of dietary calcium propionate supplementation on body measurements of the Iraqi buffalo calves at birth (Mean ± SE).

Groups	Body measurements		
	Body length (Cm)	Shoulders length (Cm)	Heart girth (Cm)
T1	64.80 ± 3.99	91.60 ± 1.88 a	89.60 ± 2.65
T2	62.80 ± 3.21	81.60 ± 0.92 b	88.20 ± 2.41
T3	60.60 ± 3.94	77.60 ± 2.85 b	86.60 ± 3.29
Level of significance	NS	$P \leq 0.01$	NS

Means with different superscripts within the same column are significantly different ($P \leq 0.01$). T1: Control without CP supplementation; T2: 100 gm dietary CP supplementation; T3: 150 g dietary CP supplementation. NS: Non-significant.

Body measurements of the buffalo calves at weaning

Non-significant differences were found among calve groups either in body length, shoulder length, or heart girth at weaning. However, there is a tendency to be greater in T1 than in both T2 and T3 groups (Table 4).

Table (4): Effect of dietary calcium propionate supplementation on body measurements of the Iraqi buffalo calves at weaning (Mean ± SE).

Groups	Body dimensions		
	Body length (Cm)	Shoulders length (Cm)	Heart girth (Cm)
T1	95.40 ± 5.96	110.60 ± 3.86	128.80 ± 4.75
T2	91.75 ± 1.03	109.00 ± 2.04	127.00 ± 3.39
T3	90.60 ± 3.82	107.40 ± 2.63	124.80 ± 5.94
Level of significance	NS	NS	NS

T1: Control without CP supplementation; T2: 100 gm dietary CP supplementation; T3: 150 g dietary CP supplementation. NS: Non-significant.

CONCLUSION

Adding of CP (100 g) to the concentrate diet of Iraqi buffaloes pre- and post-partum enhanced the MYP of Iraqi dairy buffaloes.

REFERENCES

1. Abdulkareem, T. A., Al-Sharifi, S.A.M., Eidan, S.M., & Sasser, R.G.)2012 (. Productive and reproductive performance of Iraqi buffalo as influenced of pre-mating and pre-calving concentrate supplementation. *Pakistan Veterinary Journal*, 32, 345-348.
2. Al-Qudsi, N. H., Hassan, A. A. A., & Elia, G.V. (2012). *Cattle Production*. Baghdad University House for Printing, Publishing, and Translation.
3. Arrazola, A., & Torrey, S. (2019). Conditioned place avoidance using encapsulated calcium propionate as an appetite suppressant for broiler breeders. *PLoS One*, *14*(7), e0206271.
4. Ceciliani, F., Lecchi, C., Urh, C., & Sauerwein, H. (2018). Proteomics and metabolomics characterize the pathophysiology of adaptive reactions to the metabolic challenges during the transition from late pregnancy to early lactation in dairy cows. *Journal of Proteomics*, 178, 92–106.
5. Couto Serrenho, R., DeVries, T.J., Duffield, T.F., & LeBlanc, S.J. (2021). Graduate Student Literature Review: what do we know about the effects of clinical and subclinical hypocalcemia on health and performance of dairy cows? *Journal of Dairy Science*. 104, 6304–6326.
6. Dhillod, S., Kar, D., Patil, C.S., Sahu, S., & Singh, N. (2017). Study of the dairy characters of lactation Murrah buffaloes on the basis of body parts measurements. *Veterinary Worl*, 10(1): 17-21.
7. Drackley, J. K. (1999). Biology of dairy cows during the transition period: The final frontier? *Journal of Dairy Science*, 82, 2259–2273.
8. Duncan, D.B. (1955). Multiple Rang and Multiple F-test. *Biometrics*. 11: 4-42.
9. Duplessis, M., Lapierre, H., Ouattara, B., Bissonnette, N., Pellerin, D., Laforest, J.P., & Girard, C.L. (2017). Whole-body propionate and glucose metabolism of multiparous dairy cows receiving folic acid and vitamin B12 supplements. *Journal of Dairy Science*, 100, 8578–8589.
10. EL-Delfi, M. R., & Safi, S. M. A. (2023). Effect of inhibition of weeds dry weight on wheat growth indicators: effect of inhibition of weeds dry weight on wheat growth indicators. *Iraqi Journal of Market Research and Consumer Protection*, 15(1), 213-221.
11. Harmon, D. L. (1992). Impact of nutrition on pancreatic exocrine and endocrine secretion in ruminants: a review. *Journal of Animal Science*,70, 1290–1301.

12. Hernández, E.G.S., Bouda, J., García, J.A., & Hernández, J.A.N. (2009). Effect of postpartum administration of calcium salts and glucose precursors on serum calcium and ketone bodies in dairy cows. *Veterinaria Mexico*, 40: 17-26.
13. Kara, C. (2013). Physiological and metabolic changes during the transition period and the use of calcium propionate for prevention or treatment of hypocalcemia and ketosis in periparturient cows. *Journal of Biological and Environmental Science*, 7, 9–17.
14. Khedkar, C.D., kalyankar, S.S., & Deosarkar, B, (2016). Caballero, P.M. finglas, F. Toldrá (Edc.), Encyclopedia of food and health, Academic Press, San Diego, CA, USA, 522-528.
15. Liang, G., Malmuthuge, N., Bao, H., Stothard, P., Griebel, P. J., & Guan, L. L. (2016). Transcriptome analysis reveals regional and temporal differences in mucosal immune system development in the small intestine of neonatal calves. *BMC genomics*, *17*(1), 1-16.
16. Lin, X., Liu, G., Yin, Z., Wang, Y., Hou, Q., Shi, K., & Wang, Z. (2017). Effects of supplemental dietary energy source on feed intake, lactation performance, and serum indices of early-lactating Holstein cows in a positive energy balance. *Advances in Bioscience and Biotechnology*, 8, 68–77.
17. Mejares, C. T., Huppertz, T., & Chandrapala, J. (2022). Thermal processing of buffalo milk–A review. *International Dairy Journal*, *129*, 105311.
18. Pongsavee, M. (2019). Effects of 3300 del A-1061 Ter BRCA1 frameshift mutation and calcium propionate on oxidative stress and breast carcinogenesis. *International Journal of Molecular Epidemiology and Genetics*, 10, 47–52.
19. SAS. (2018). Statistical Analysis System, User's Guide. Statistical. Version 9.6th ed. SAS. *Inst. Inc*. Cary. N.C. USA.
20. Sequeira, S.O., Phillips, A.J.L., Cabrita, E.J., & Macedo, M.F. (2017). Antifungal treatment of paper with calcium propionate and parabens: Short-term and long-term effects. *International Biodeterioration and Biodegradation.*, 120, 203–215.
21. Singh, A. K., Bhakat C., Mandal, D.K., Mandal, A., Rai, S., & Chatterjee, A. (2020). Effect of reducing energy intake during dry period on milk production, udder health and body condition score of Jersey crossbred cows at tropical lower Gangetic region. *Trop. Anim. Health Prod.* 52, 1759-1767.
22. Wala'a Mohammed Abdullah, W., Abraheem, I., & Abdullah, A. N. (2023). Association of cyp17 gene polymorphisme in productive and reproductive performance in goat. *Iraqi Journal of Market Research and Consumer Protection*, 15(1), 66-71.
23. Wigati, L. P., Wardana, A. A., Tanaka, F., & Tanaka, F. (2022). Edible film of native jicama starch, agarwood Aetoxylon Bouya essential oil and calcium propionate: Processing, mechanical, thermal properties and structure. *International Journal of Biological Macromolecules*, *209*, 597-607.
24. Wilkens, M.R., Nelson, C.D., Hernandez, L.L., & McArt, J.A.A. (2020). Symposium review: Transition cow calcium homeostasis—Health effects of hypocalcemia and strategies for prevention. *Journal of Dairy Science* 103, 2909–2927.
25. Yano, F., Yano, H., & Breves, G. (1991). Calcium and phosphorus metabolism in ruminants. In: *Physiological Aspects of Digestion and Metabolism in Ruminants*. Academic Press. pp. 277-295.
26. Zhang, X. Z., Chen, W.B., Wu, X., Zhang, Y.W., Jiang, Y.M., XMeng, Q., & Zhou. Z.M. (2018). Calcium propionate supplementation improves development of rumen epithelium in calves via stimulating G protein-coupled receptors. *Animal*, 12:2284–2291.