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Blood mineral response and field performance of a nano-calcium-phosphorus-selenium oral supplement in dairy cattle: comparative evidence from Bangladesh and India

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ABSTRACT

Background: Periparturient calcium insufficiency is a common metabolic challenge in dairy cattle, while selenium status influences antioxidant defence. This study evaluated a liquid nano-mineral formulation (NanoCal Se) containing nano-calcium, nano-phosphorus and selenium, supported by vitamins D3, B12 and biotin. **Methods:** A 42-day comparative field evaluation in Bangladesh enrolled 100 cattle (50 NanoCal Se; 50 regular calcium-phosphorus supplement). Serum total calcium and inorganic phosphorus were measured on Day 0 and Day 42. A supporting Indian field dataset comprised 75 farmer-level observations from Rakab, Maanbazar and Mahadevpur, West Bengal, reporting percentage change in milk production after product use. Physicochemical evidence included transmission electron microscopy (TEM) and zeta-potential characterization. Between-group Day 0 and Day 42 differences were re-analysed from group summary statistics using Welch tests and Hedges *g*. **Results:** Baseline calcium and phosphorus were similar between Bangladesh groups ($P = 0.812$ and $P = 0.828$, respectively). By Day 42, serum calcium was 9.38 ± 0.39 mg/dL with NanoCal Se versus 8.55 ± 0.46 mg/dL with the regular supplement (difference 0.83 mg/dL, 95% CI 0.66-1.00; $P < 0.001$; Hedges $g = 1.93$). Serum phosphorus was 5.64 ± 0.42 versus 5.01 ± 0.49 mg/dL (difference 0.63 mg/dL, 95% CI 0.45-0.81; $P < 0.001$; $g = 1.37$). The reported rise from baseline was 15.52% versus 5.56% for calcium and 20.51% versus 6.60% for phosphorus. In the Indian field observations, mean reported milk-production improvement was $32.68 \pm 17.72\%$ overall, with significant between-site heterogeneity (ANOVA $P < 0.001$). TEM showed nanoscale/submicron particulate morphology and the measured mean zeta potential was -40.33 mV. **Conclusion:** Under the reported field conditions, NanoCal Se was associated with a greater Day-42 blood calcium and phosphorus response than the regular supplement. The milk-production observations are supportive but uncontrolled and should not be interpreted as causal efficacy evidence. Larger randomized trials with animal-level datasets, prespecified endpoints and formal safety monitoring are warranted.

Keywords: Dairy cattle, Nano-calcium, Nano-phosphorus, Nano-selenium, Hypocalcaemia, Mineral supplementation, Milk production

1. Introduction

Calcium homeostasis is challenged sharply at the onset of lactation. Even in the absence of overt milk fever, subclinical hypocalcaemia can be common in early-lactation cows and has been associated with impaired immune and metabolic function and with postpartum disease risk (Martinez *et al.*, 2012) [1]. Oral calcium supplementation is therefore widely used; however, the response depends on product chemistry, dose, timing, parity and baseline nutritional management. A 2024 meta-analysis of 22 studies found that oral calcium supplementation increased blood calcium and reduced the risk of clinical and subclinical hypocalcaemia, while effects on milk yield and several other outcomes were inconsistent (Ma *et al.*, 2024) [2].

Nanotechnology has been proposed as a means of altering mineral dispersion, surface area and dissolution behaviour. Reviews of nano-minerals in livestock nutrition describe potential for biological effects at lower inclusion rates, although the evidence base varies substantially among minerals and formulations (Swain *et al.*, 2015) [3]. Selenium is especially relevant because it is incorporated into glutathione peroxidases and other selenoproteins. Controlled studies in dairy cows have reported that nano-selenium can increase plasma or milk selenium and glutathione-peroxidase activity compared with sodium selenite, while effects on milk yield have differed among studies (Han *et al.*, 2021; Xiao *et al.*, 2024) [4, 5].

NanoCal Se is a liquid oral supplement developed by Invati Creations Private Limited. The formulation combines nano-calcium and nano-phosphorus with selenium, vitamin D3, vitamin B12 and biotin. The

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present manuscript integrates a 42-day Bangladesh comparative field evaluation with an independent set of Indian field observations, and reports a transparent statistical re-analysis of the available summary data. A secondary objective was to relate biological findings to available physicochemical characterization, while explicitly separating analytical evidence from claims of in-vivo superiority.

2. Materials and Methods

2.1 Test formulation and daily oral dose

The evaluated formulation was NanoCal Se, supplied as an aqueous colloidal liquid. The label/formulation specification used in the supplied technical dossier is shown in Table 1. The cattle dose used in the Bangladesh evaluation was 50 mL orally once daily.

2.2 Physicochemical characterization

The supplied analytical dossier included a TEM micrograph with a 500 nm scale bar showing a dispersed population of nanoscale/submicron particles. A Malvern Panalytical zeta-potential measurement recorded a mean of -40.33 mV and a principal peak mean of -40.41 mV at 25 °C. An absolute zeta-potential magnitude around 40 mV is consistent with strong electrostatic stabilization under the measurement conditions. These measurements support nanoparticulate morphology and colloidal stability; they do not, by themselves, demonstrate gastrointestinal absorption or clinical superiority. Representative analytical evidence is shown in Figures 5-7. The current source package included a TEM micrograph and a Malvern zeta-potential report; however, a full batch-wise DLS particle-size distribution printout was not supplied. Accordingly, Figure 7 summarizes the declared nanoscale particle-size specification (< 100 nm) of the three mineral phases from the product dossier rather than a measured DLS distribution curve.

Table 1. Declared composition of NanoCal Se and calculated amount supplied by a 50 mL daily dose.

Component	Declared concentration per mL	Amount per 50 mL	Functional context
Nano calcium	17 mg	850 mg	Calcium supplementation
Nano phosphorus	8.5 mg	425 mg	Phosphorus supplementation
Vitamin D3	10 IU	500 IU	Supports calcium-phosphorus metabolism
Vitamin B12	1 microgram	50 microgram	Vitamin support
Biotin	50 microgram	2.5 mg	Metabolic/hoof-related vitamin support
Selenium	30 microgram	1.5 mg	Selenoprotein and antioxidant nutrition

Note: Total dietary selenium exposure from the basal ration and all supplements should be checked against applicable species-specific feed limits.

2.3 Bangladesh comparative field evaluation

The Bangladesh field report described a 42-day evaluation conducted in Dhaka from 12 April 2025 [6] to 24 May 2025 [6]. One hundred cattle were enrolled and allocated to two groups of 50. Group 1 received NanoCal Se at 50 mL orally once daily. Group 2 received a regular calcium-phosphorus supplement at the label-recommended daily dose. Both groups remained on the normal farm ration. Serum samples were collected at baseline (Day 0) and Day 42 for total calcium and inorganic phosphorus. The analysis in this manuscript uses the signed summary report values supplied in the company study file.

2.4 Supporting Indian field observations

A February-April 2025 [7] field feedback dataset from West Bengal contained 75 recipient-level records, 25 each from Rakab, Maanbazar and Mahadevpur. Each record reported a percentage “development in milk production” after use of the nano-calcium product. The dataset did not include a contemporaneous untreated control, standardized baseline milk yield, duration for every animal, parity, stage of lactation or ration covariates. Therefore, these records were analysed as observational field-support data rather than as a controlled efficacy trial.

Table 2. Bangladesh field-evaluation design.

Study component	NanoCal Se	Regular supplement
Number of cattle	50	50
Supplementation	50 mL orally once daily	Label-recommended dose
Basal ration	Normal farm ration	Same normal farm ration
Observation period	Day 0 to Day 42	Day 0 to Day 42
Blood sampling	Day 0 and Day 42	Day 0 and Day 42
Primary laboratory endpoints	Serum total Ca; inorganic P	Serum total Ca; inorganic P

2.5 Statistical analysis

For the Bangladesh evaluation, group means and standard deviations were available at Day 0 and Day 42 ($n = 50/\text{group}$). Between-group differences at each time point were assessed post hoc from summary statistics using Welch independent-samples *t* tests. Mean differences are presented with 95% confidence intervals, and standardized effects as Hedges *g*. Because animal-level paired values were not available for this re-analysis, within-animal paired tests and a formal treatment-

by-time interaction were not calculated. Percentage changes reported in the source field report are presented descriptively.

For the Indian field observations, mean, standard deviation, median, range and 95% confidence intervals were calculated by site and overall. Site heterogeneity was explored using one-way ANOVA, with Kruskal-Wallis as a non-parametric sensitivity analysis. $P < 0.05$ was considered statistically significant. The site test should not be interpreted as evidence that geography itself caused the differences, because allocation and management factors were uncontrolled.

3. Results

3.1 Serum total calcium

At baseline, mean serum calcium was 8.12 ± 0.41 mg/dL in the NanoCal Se group and 8.10 ± 0.43 mg/dL in the regular-supplement group; the 0.02 mg/dL difference was not significant ($P = 0.812$). At

Day 42, means were 9.38 ± 0.39 and 8.55 ± 0.46 mg/dL, respectively. The between-group difference was 0.83 mg/dL (95% CI 0.66-1.00; $P < 0.001$), with Hedges $g = 1.93$. Relative to baseline, the source report recorded increases of 15.52% for NanoCal Se and 5.56% for the regular supplement.

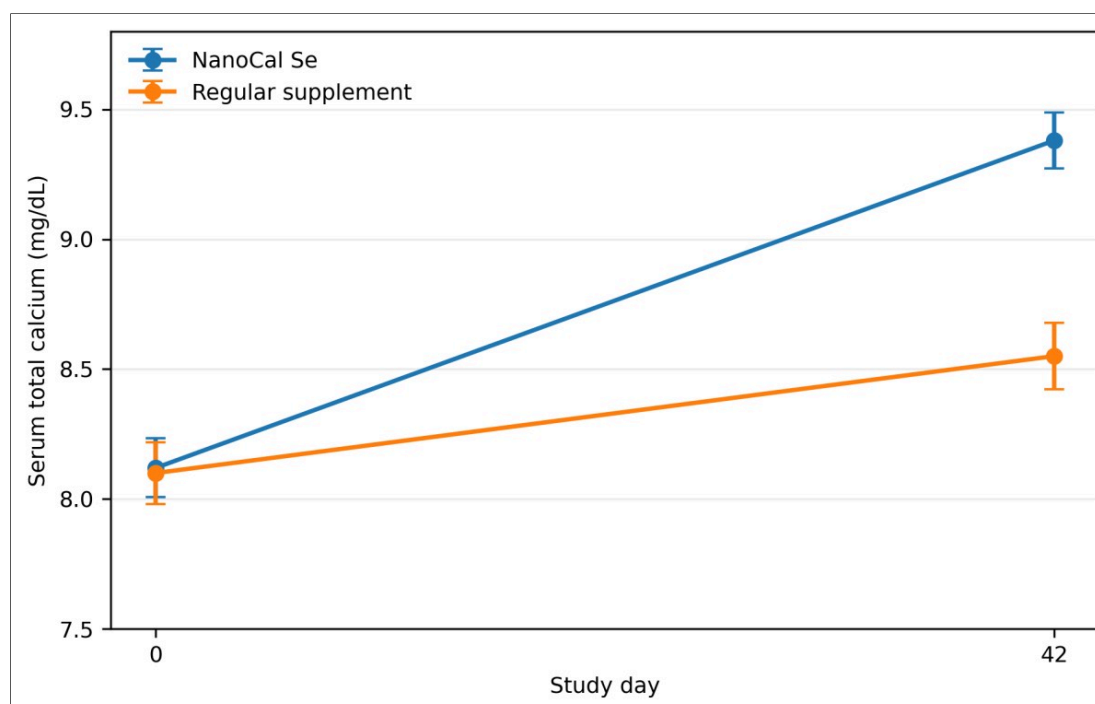


Figure 1. Serum total calcium at Day 0 and Day 42 in the Bangladesh field evaluation. Points show group means; error bars show approximate 95% confidence intervals calculated from the reported SD and $n = 50$ /group.

3.2 Serum inorganic phosphorus

Baseline serum inorganic phosphorus was also similar between groups (4.68 ± 0.45 vs 4.70 ± 0.47 mg/dL; $P = 0.828$). At Day 42, the NanoCal Se group had a mean of 5.64 ± 0.42 mg/dL compared with

5.01 ± 0.49 mg/dL in the regular-supplement group. The between-group difference was 0.63 mg/dL (95% CI 0.45-0.81; $P < 0.001$), with Hedges $g = 1.37$. The reported baseline-to-Day-42 increases were 20.51% and 6.60%, respectively.

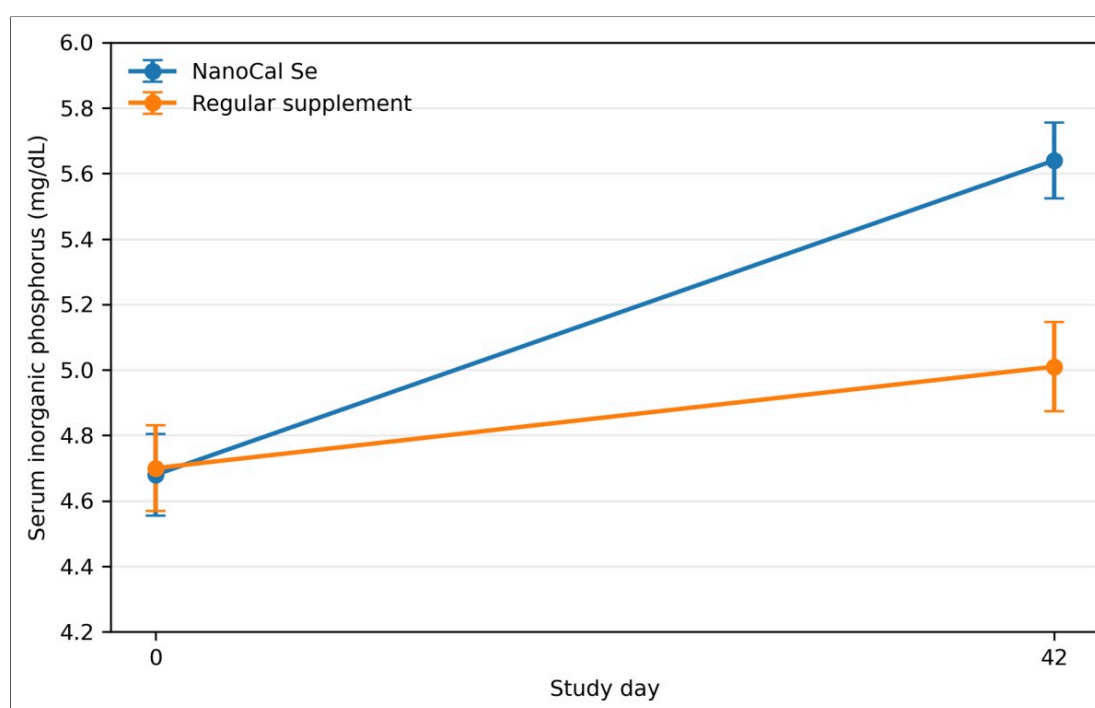
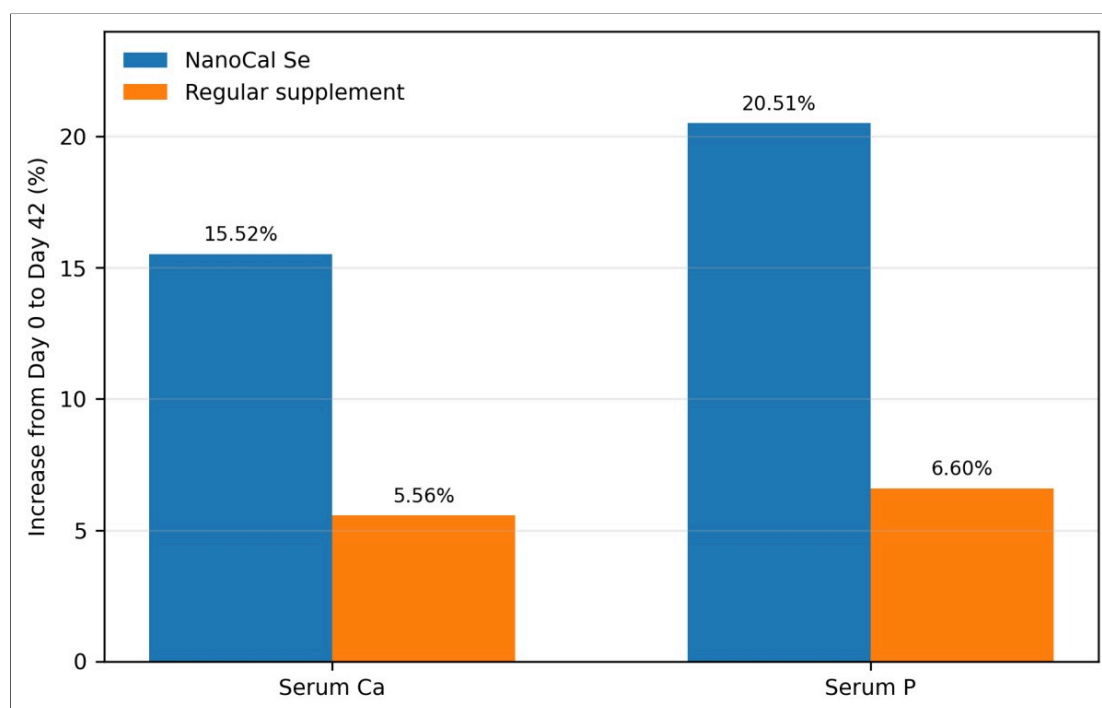


Figure 2. Serum inorganic phosphorus at Day 0 and Day 42 in the Bangladesh field evaluation. Points show group means; error bars show approximate 95% confidence intervals calculated from the reported SD and $n = 50$ /group.

Table 3. Blood mineral outcomes in the Bangladesh evaluation.

Parameter	Group	Day 0	Day 42	Absolute increase	Increase (%)
Total Ca (mg/dL)	NanoCal Se	8.12 ± 0.41	9.38 ± 0.39	1.26	15.52
Total Ca (mg/dL)	Regular supplement	8.10 ± 0.43	8.55 ± 0.46	0.45	5.56
Inorganic P (mg/dL)	NanoCal Se	4.68 ± 0.45	5.64 ± 0.42	0.96	20.51
Inorganic P (mg/dL)	Regular supplement	4.70 ± 0.47	5.01 ± 0.49	0.31	6.60



*NanoCal Se minus regular supplement. Inferential tests are between-group comparisons at each time point; they are not paired change tests.

Figure 3. Descriptive percentage increase in serum calcium and phosphorus from Day 0 to Day 42, as reported in the Bangladesh field re-

port. No inferential test of change was performed because paired animal-level data were unavailable.

Table 4. Post-hoc between-group statistical comparisons reconstructed from reported summary statistics.

Endpoint	Mean difference*	95% CI	Welch <i>t</i>	df	<i>P</i> value	Hedges <i>g</i>
Calcium, Day 0	0.02	-0.15 to 0.19	0.24	97.8	0.812	0.05
Calcium, Day 42	0.83	0.66 to 1.00	9.73	95.4	< 0.001	1.93
Phosphorus, Day 0	-0.02	-0.20 to 0.16	-0.22	97.8	0.828	-0.04
Phosphorus, Day 42	0.63	0.45 to 0.81	6.90	95.8	< 0.001	1.37

3.3 Indian field observations on milk production

Across 75 West Bengal field records, the mean reported improvement in milk production was 32.68 ± 17.72%, with a median of 30% and range 5-90%. Site means were 20.76% in Rakab, 46.08% in

Maanbazar and 31.20% in Mahadevpur. Site heterogeneity was statistically evident (ANOVA $F = 19.23$, $P < 0.001$; Kruskal-Wallis $H = 27.63$, $P < 0.001$). Because this was an uncontrolled feedback dataset, these percentages cannot establish treatment-attributable milk-yield efficacy.

Table 5. Descriptive statistics for reported milk-production improvement in West Bengal field observations.

Site	n	Mean (%)	SD	Median	Range	95% CI	Interpretation
Rakab	25	20.76	11.62	15	10-50	15.96-25.56	Field-reported response; uncontrolled
Maanbazar	25	46.08	20.87	40	5-90	37.47-54.69	Field-reported response; uncontrolled
Mahadevpur	25	31.20	7.81	30	20-40	27.98-34.42	Field-reported response; uncontrolled
Overall	75	32.68	17.72	30	5-90	28.60-36.76	Supportive observational signal

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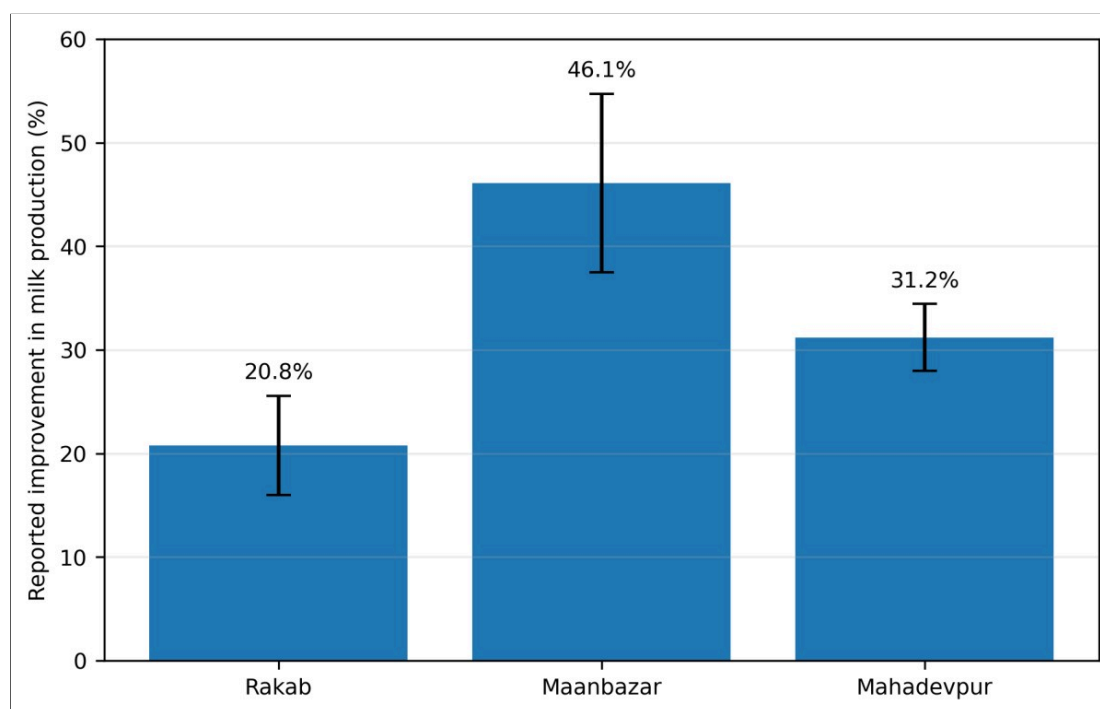


Figure 4. Mean reported improvement in milk production by West Bengal field site ($n = 25/\text{site}$). Error bars are 95% confidence intervals. The site differences may reflect animal, ration, lactation-stage or management differences and are not causal estimates.

3.4 Physicochemical evidence

The supplied TEM image directly demonstrated a population of small particulate structures at the nanoscale/submicron scale. The measured mean zeta potential was -40.33 mV (principal peak -40.41 mV), supporting a strongly charged colloidal dispersion under the stated measurement conditions. These findings provide a physicochemical basis

for examining altered dispersion and dissolution, but a direct link to systemic mineral uptake requires controlled in-vivo pharmacokinetic or balance studies. The representative TEM image (Figure 5) and the zeta-potential report (Figure 6) are reproduced below. In the absence of a supplied DLS printout, Figure 7 summarizes the declared $< 100 \text{ nm}$ specification for the nano-calcium, nano-phosphorus and nano-selenium phases.

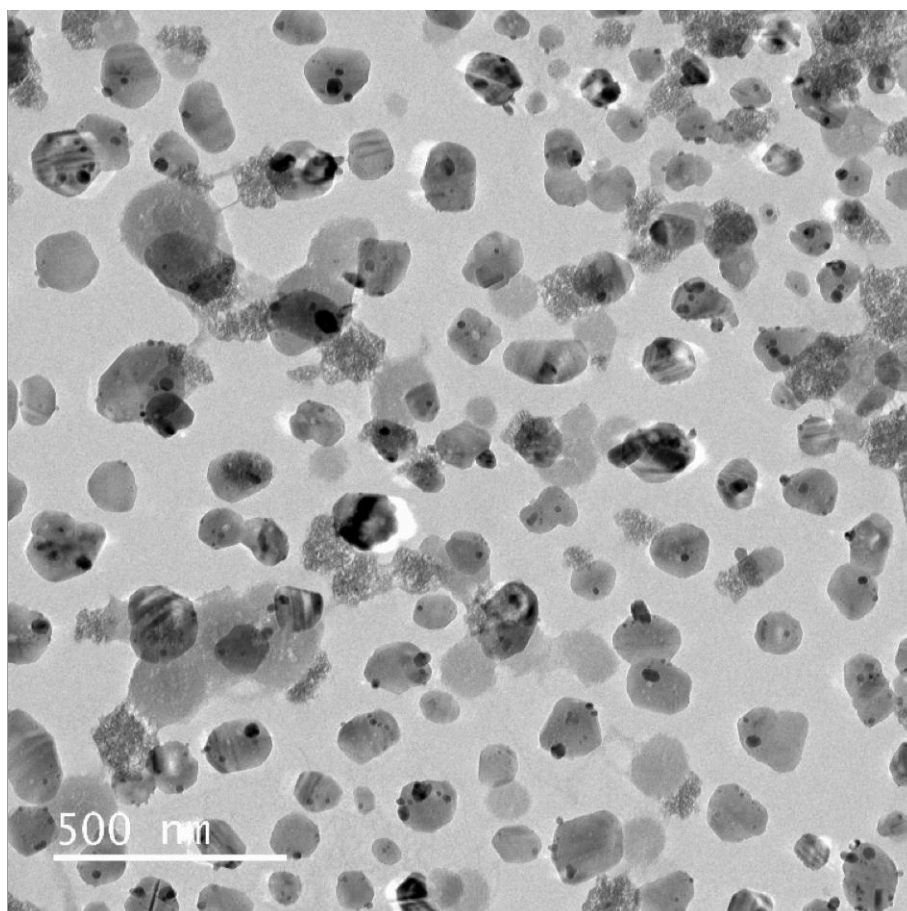
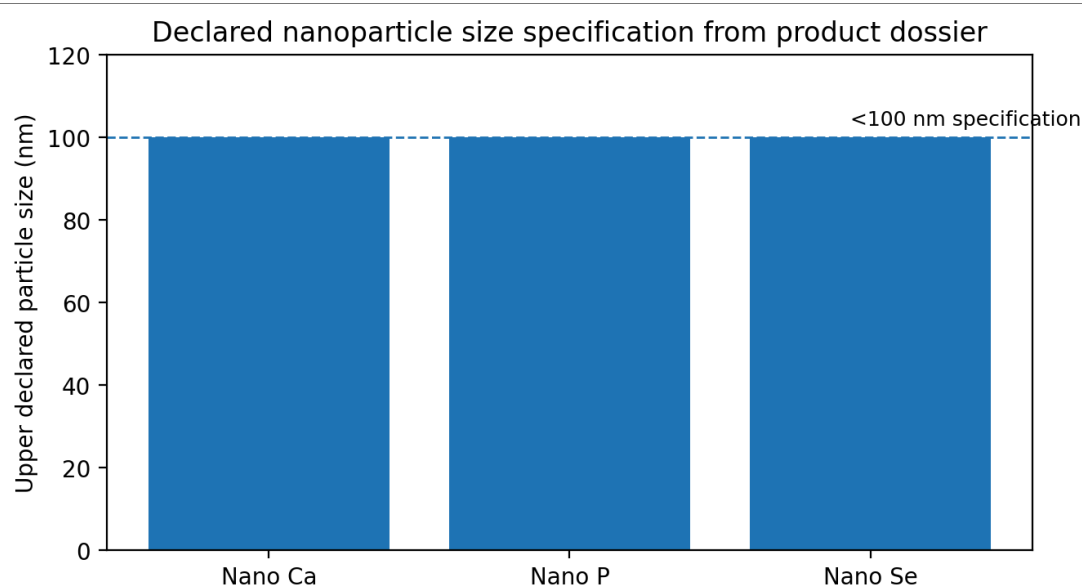


Figure 5. TEM micrograph supplied for NanoCal Se showing a dispersed population of nanoscale/submicron particulate structures; the original 500 nm scale bar is retained.



Figure 6. Malvern Panalytical zeta-potential report for the NanoCal Se sample, showing a mean zeta potential of -40.33 mV and principal peak mean of -40.41 mV.



Note: The supplied dossier declared calcium, phosphorus and selenium nanoparticles as <100 nm. A full batch-wise DLS particle-size distribution curve was not included in the present source package.

Figure 7. Declared upper particle-size specification (< 100 nm) for the nano-calcium, nano-phosphorus and nano-selenium phases from the product dossier/MSDS. This is a specification summary and not a measured DLS particle-size distribution curve, because a batch-wise DLS printout was not included in the present source package.

4. Discussion

The principal finding was a larger Day-42 serum calcium and inorganic phosphorus concentration in cattle receiving NanoCal Se than in cattle receiving a regular mineral supplement, with very small baseline differences and large standardized between-group effects at Day 42. The direction of the calcium finding is biologically consistent

with the broader oral-calcium literature: a recent *meta-analysis* reported a modest overall increase in blood calcium and a reduced risk of postpartum hypocalcaemia after oral calcium supplementation (Ma *et al.*, 2024) [2]. However, direct comparison of effect size is inappropriate because the present field evaluation used a different formulation, a 42-day schedule and a conventional active comparator rather than no supplementation.

A second plausible component is selenium-mediated antioxidant support. (Han *et al.*) [4] reported greater plasma selenium and glutathione-peroxidase activity with nano-selenium than sodium selenite in lactating cows, although milk yield was unchanged in that small study. In contrast, (Xiao *et al.*) [5] found higher milk yield and feed efficiency with nanoselenium during peak lactation. These differing results reinforce the need to separate mineral status, antioxidant biomarkers and productivity outcomes rather than assuming that improvement in one necessarily translates into another.

The Indian feedback dataset showed an overall mean reported milk-production improvement of approximately one-third, but the wide SD and marked site heterogeneity are important. Without a concurrent control, standardized pre-treatment milk records, parity and stage-of-lactation adjustment, ration data and blinded outcome capture, regression to the mean and management changes cannot be excluded. Accordingly, these data are best treated as hypothesis-generating field surveillance. This interpretation is also consistent with the 2024 meta-analysis, which did not find a pooled milk-yield benefit from oral calcium supplementation despite clearer effects on blood calcium and hypocalcaemia risk [2].

The physicochemical evidence strengthens the formulation description but should not be overextended. TEM is direct evidence of particulate morphology, and a zeta potential of approximately -40 mV indicates substantial electrostatic stabilization in the tested medium. Neither measurement proves intestinal uptake, systemic bioavailability or prevention of milk fever. Future studies should characterize each test batch by DLS size distribution/PDI, TEM, zeta potential, elemental assay and phase identity, and should pair these measurements with serial serum ionized and total calcium, phosphorus, magnesium, selenium status, glutathione-peroxidase activity and clinical outcomes.

4.1 Strengths and limitations

- The Bangladesh evaluation included an active comparator and equal group sizes (50/group), with baseline and Day-42 blood-mineral measurements.
- The manuscript provides confidence intervals and standardized effect sizes rather than relying only on percentage change.
- The statistical re-analysis is constrained by summary-level data; raw paired values were unavailable, so a treatment-by-time interaction could not be tested.
- Randomization, blinding, detailed eligibility criteria, parity distribution, lactation stage, ration composition, compliance and adverse-event capture were not fully documented in the source report.
- The Indian milk-response dataset was uncontrolled and should not be used as confirmatory evidence of a milk-yield claim.
- TEM and zeta potential establish physicochemical characteristics, not in-vivo bioavailability or clinical efficacy.

4.2 Recommended confirmatory trial

A publication-grade confirmatory study should be prospective, randomized and blinded at outcome assessment, with predefined sample-size calculation. A pragmatic design could include NanoCal Se, a conventional oral calcium-phosphorus supplement and standard-of-care control where ethically acceptable. Primary endpoints should include serial serum ionized calcium or total calcium area under the curve and incidence of predefined subclinical hypocalcaemia. Secondary endpoints may include phosphorus, magnesium, selenium status, GPx activity, milk yield, feed intake, retained placenta/metritis, recurrence of hypocalcaemia and tolerability. Animal-level data should be retained to permit mixed-effects repeated-measures analysis.

5. Conclusion

In the available 42-day Bangladesh field evaluation, NanoCal Se was associated with higher Day-42 serum total calcium and inorganic phosphorus than a regular mineral supplement, while baseline values

were similar. The magnitude of the between-group differences was large in the post-hoc summary-statistic analysis. Supporting Indian field observations showed increased reported milk production in many recipients, but the absence of a concurrent control and the strong site heterogeneity mean that these milk data should remain exploratory. The combined evidence supports further randomized, animal-level validation of this nano-mineral platform, with rigorous safety and batch characterization.

Commercially, NanoCal-Se is already available in Bangladesh under Renata PLC (Animal Health). According to Invati's commercial declaration, the Bangladesh white-label/marketing arrangement is handled through Nanovet; the product formulation and underlying nano-scaling technology remain exclusively owned by Invati Creations Private Limited, and Nanovet is required under the applicable commercial arrangement to procure the corresponding white-label formulation from Invati. This ownership and supply statement is a commercial/IP disclosure and is not part of the efficacy analysis.

6. Declarations

Author contributions: Nilanjan Deb - conceptualization, formulation development, scientific interpretation and manuscript drafting; Parijat Bhattacharya - scientific interpretation and manuscript drafting; Biresh Koley - formal analysis; Ritam Santra - formal analysis

Conflict of interest and commercial disclosure: The test formulation and nano-scaling technology are proprietary to Invati Creations Private Limited. The author is affiliated with Invati. NanoCal-Se is commercially listed in Bangladesh under Renata PLC (Animal Health). The white-label/marketing and supply relationship involving Nanovet is reported here as a company-declared commercial arrangement. These interests should be disclosed to the target journal in full.

Data availability: Summary datasets used for the analyses are contained in the company field reports. De-identified animal-level laboratory data should be made available to editors/reviewers or deposited as supplementary material before/at submission where permitted.

References

1. Martinez N, Risco CA, Lima FS, Bisinotto RS, Greco LF, Ribeiro ES, Maunsell F, Galvao K, Santos JEP. Evaluation of periparturient calcium status, energetic profile, and neutrophil function in dairy cows at low or high risk of developing uterine disease. *J Dairy Sci.* 2012;95(12):7158-7172.
2. Ma ZR, Ma LL, Zhao F, Bo Y. Effects of oral calcium on reproduction and postpartum health in cattle: a meta-analysis and quality assessment. *Front Vet Sci.* 2024;11:1357640.
3. Swain PS, Rajendran D, Rao SBN, Dominic G. Preparation and effects of nano mineral particle feeding in livestock: A review. *Vet World.* 2015;8(7):888-891.
4. Han L, Pang K, Fu T, Phillips CJC, Gao T. Nano-selenium supplementation increases selenoprotein gene expression profiles and milk selenium concentration in lactating dairy cows. *Biol Trace Elem Res.* 2021;199(1):113-119.
5. Xiao M, Wang Y, Wei M, Peng W, Wang Y, Zhang R, Zheng Y, Ju J, Dong C, Du L, Bao M. Effects of nanoselenium on the performance, blood indices, and milk metabolites of dairy cows during the peak lactation period. *Front Vet Sci.* 2024;11:1418165.
6. Invati Creations Private Limited. NanoCal Se Bangladesh Dairy Farm Field Evaluation Report: blood calcium and phosphorus response to NanoCal Se compared with a conventional mineral supplement. Company study report; 2025.
7. Invati Creations Private Limited. Nano Calcium Feedback Report: Rakab, Maanbazar and Mahadevpur, West Bengal, February-April 2025. Company field report; 2025.
8. Frost IR, Seely CR, McCray HA, Callero KR, Seminara JA, Martinez RM, Reid AM, Wilbur CN, Koebel KJ, McArt JAA. Effect of postpartum calcium supplementation on serum calcium and parathyroid hormone concentrations in multiparous Holstein cows. *JDS Commun.* 2024;5(3):215-219.

9. Afshar Farnia S, Rasooli A, Nouri M, Shahryari A, Khosravi Bakhtiary M, Constable PD. Effect of postparturient oral calcium administration on serum total calcium concentration in Holstein cows fed diets of different dietary cation-anion difference in late gestation. *Res Vet Sci.* 2018;117:118-124.
10. Valdecabres A, Pires JAA, Silva-del-Rio N. Effect of prophylactic oral calcium supplementation on postpartum mineral status and markers of energy balance of multiparous Jersey cows. *J Dairy Sci.* 2018;101(5):4460-4472.
11. Aroga. NanoCal-Se 500 mL (Vet), *Renata PLC* (Animal Health), Bangladesh. Online product listing; 2026.

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