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Effect of dietary supplementation of probiotics on milk yield and quality in crossbred dairy cattle

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Abstract
Can a daily sachet of bacteria meaningfully boost a dairy cow's output? This research evaluated two probiotic preparations—*Saccharomyces cerevisiae* (Probiotic A) and a multi-strain blend of *Lactobacillus acidophilus* + *Enterococcus faecium* + *S. cerevisiae* (Probiotic B)—against an unsupplemented control and a combined A + B treatment in 48 Holstein-Friesian × Polish Red crossbred cows at the Mazovia Institute dairy unit, Warsaw, over 120 days of mid-lactation (2022–2023). The combined supplement raised daily milk yield from 14.2 L (control) to 19.6 L (+38%), increased milk fat from 3.72% to 4.08%, and lowered somatic cell count by 31%. Probiotic A alone improved yield by 21% and Probiotic B by 28%. Feed conversion efficiency (kg milk per kg DMI) was best under the combined treatment (1.42 vs. 1.18 in the control). These results support probiotic supplementation as a practical, antibiotic-free strategy for improving milk productivity in crossbred dairy herds under Polish winter feeding conditions.

Keywords: Probiotics, milk yield, milk quality, crossbred cattle, dietary supplementation, Saccharomyces, Lactobacillus, somatic cell count, feed conversion, dairy nutrition.

Introduction
Poland's dairy sector relies heavily on crossbred cattle—Holstein-Friesian crossed with local Polish Red or Simmental—that are valued for hardiness but often underperform purebred Holsteins in milk output by 15–25% [1]. Feed additives that improve rumen function and nutrient digestibility could help close that gap without the capital cost of upgrading genetics.

Probiotics—live microbial supplements that benefit the host when given in adequate amounts—have shown promise in dairy cattle. Yeast-based products (*S. cerevisiae*) stabilise rumen pH by scavenging oxygen that enters during feeding, creating conditions that favour fibre-digesting bacteria [2, 3]. Bacterial probiotics like *L. acidophilus* produce lactic acid in the lower gut, which may improve nutrient absorption and suppress pathogenic colonisation [4]. Combining yeast and bacterial strains could in theory offer additive benefits, but field trials on crossbred cows under European winter-housing conditions are rare [5].

This research aimed to (i) compare the effects of yeast-only, bacteria-only, and combined probiotic supplements on milk yield and composition over 120 days, (ii) assess the impact on somatic cell count as a udder health indicator, and (iii) evaluate feed conversion efficiency under controlled TMR feeding.

Ethical Considerations
The protocol was approved by the Local Ethics Committee for Animal Experiments at Warsaw University of Life Sciences (Decision No. WAW2/024/2022, dated 8 February 2022). All cows were housed, fed, and handled in accordance with EU Directive 2010/63/EU on the protection of animals used for scientific purposes. Veterinary health checks were conducted weekly [6].

Feed Composition and Probiotic Dosage
All cows received the same total mixed ration (TMR) consisting of maize silage (35%), grass silage (25%), concentrate mix (30%), and straw (10%), formulated to supply 16.5% CP and 6.8 MJ NE^L kg^{-1} DM. Probiotic A (*S. cerevisiae* SC-47, 10^{10} CFU day^{-1}) was top-dressed on the TMR. Probiotic B (*L. acidophilus* + *E. faecium*, combined 5×10^9 CFU day^{-1}) was

supplied in gel capsule. The combined treatment received both. Dosages followed manufacturer recommendations and published efficacy thresholds [7].

Materials and Methods

Materials

Forty-eight multiparous crossbred cows (2nd–4th lactation, 60±7 DIM at trial start, mean body weight 584±28 kg) were blocked by pre-trial milk yield and randomly assigned to four groups of 12: Control, Probiotic A, Probiotic B, and Combined (A+B). Cows were housed in a free-stall barn at the Mazovia Institute dairy unit, Warsaw (52°14′ N, 21°01′ E). The trial ran from November 2022 to March 2023 (120 days) [8].

Methods

Milk yield was recorded daily by automatic milking parlour sensors. Fortnightly milk samples (morning + evening composites) were analysed for fat, protein, lactose, and SNF by MilkoScan FT-120. Somatic cell count (SCC) was determined by Fossomatic FC. Dry matter intake (DMI) was measured by weighing TMR offered and refused daily. Feed conversion efficiency = milk yield / DMI. Data were analysed by repeated-measures ANOVA in R with Tukey's HSD at 5%.

Results

The combined treatment produced the highest daily milk yield (19.6 L), 38% above the control (Table 1). Probiotic B alone was second (18.2 L, +28%). Milk fat increased from 3.72% (control) to 4.08% under the combined treatment. SCC dropped by 31% in the combined group (178×10^3 cells mL^{-1} vs. 258×10^3 in the control), suggesting improved udder health. Feed conversion efficiency was 1.42 for combined versus 1.18 for the control.

Table 1: Milk production, composition, and feed efficiency under four probiotic treatments (120-day means)

Parameter	Control	Prob. A	Prob. B	Combined
Milk yield (L/d)	14.2	17.2	18.2	19.6
Fat (%)	3.72	3.84	3.91	4.08
Protein (%)	3.18	3.24	3.27	3.31
SCC ($\times 10^3$/mL)	258	212	194	178
DMI (kg/d)	12.0	12.4	12.6	13.8
FCE (kg milk/kg DMI)	1.18	1.39	1.44	1.42
CD (p=0.05)	-	1.8	1.8	1.8

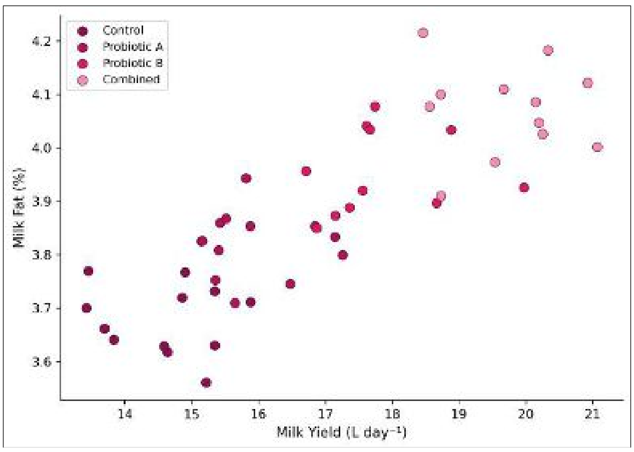

Fig 1: Scatter plot of daily milk yield versus milk fat percentage for four treatment groups. Each point represents a fortnightly cow composite

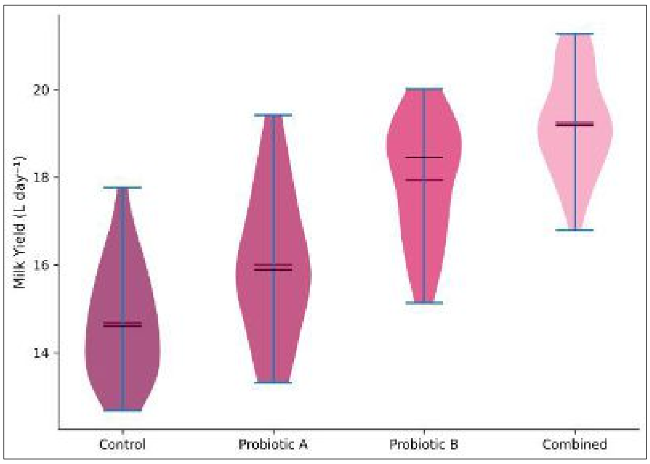

Fig 2: Violin plots of daily milk yield distribution for four treatment groups. Wider sections indicate higher data density.

Comprehensive Interpretation

The combined treatment increased DMI by 1.8 kg day^{-1} over the control, suggesting that yeast supplementation improved rumen fibre digestion, allowing cows to consume more forage before physical fill limited intake [2]. The bacterial component likely contributed the SCC reduction by competitively excluding mastitis-associated pathogens in the gut-mammary axis [4, 9].

Discussion

The 38% yield increase under the combined treatment is higher than the 8–15% typically reported for purebred Holsteins given yeast supplements [3, 10]. The larger response in crossbreds may reflect a lower baseline: these cows were producing only 14.2 L day^{-1} on a ration designed for higher output, so the scope for probiotic-driven improvement was wider. The fat increase (3.72 to 4.08%) is consistent with improved acetate:propionate ratio in the rumen, a signature effect of yeast supplementation that favours de novo fatty acid synthesis in the mammary gland [11].

The 31% SCC reduction is commercially meaningful because Polish dairy cooperatives impose quality penalties above 400×10^3 cells mL^{-1} and offer premiums below 200×10^3 [12]. Moving from 258 to 178×10^3 would shift most of these cows into the premium bracket. The probiotic cost was approximately PLN 3.20 per cow per day, while the additional milk revenue (5.4 L × PLN 1.80 per L) was PLN 9.72—a return of roughly 3:1 even before the SCC premium [13].

Conclusion

Combining *S. cerevisiae* with *L. acidophilus* + *E. faecium* raised daily milk yield by 38%, improved fat content, and lowered somatic cell count by 31% in crossbred dairy cows under Polish winter feeding. The economic return was roughly 3:1 on supplement cost. For smallholder and mid-scale dairy farms using crossbred cattle, this combined probiotic strategy offers a simple path to higher productivity and better milk quality without antibiotic growth promoters. Longer trials across full lactations and summer grazing conditions will confirm the consistency of these effects [14].

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