Protein Concentrations in Cows' Milk During the Four Stages of Lactation

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Introduction

Research Question

To what extent does protein concentration vary in samples of cows' milk collected from the four stages of lactation?

Hypothesis

If protein concentrations are measured in samples of cows' milk collected from the four stages of lactation, then the total protein concentration will decline in later stages of lactation because protein is an essential nutrient required for the development of a calf early in life.

Background Information

- Casein and whey are the two primary milk proteins.
- Undigested whey is responsible for the symptoms of lactose intolerance.

Related Literature

- Multiple studies have identified fluctuations in milk protein concentrations.
- Czech Journal of Animal Science (2014)
  - Effect of feed restrictions and acute stress factors on milk protein yield
- National Academy of Sciences (2012)
  - Targeted microRNA expression of beta-lactoglobulin

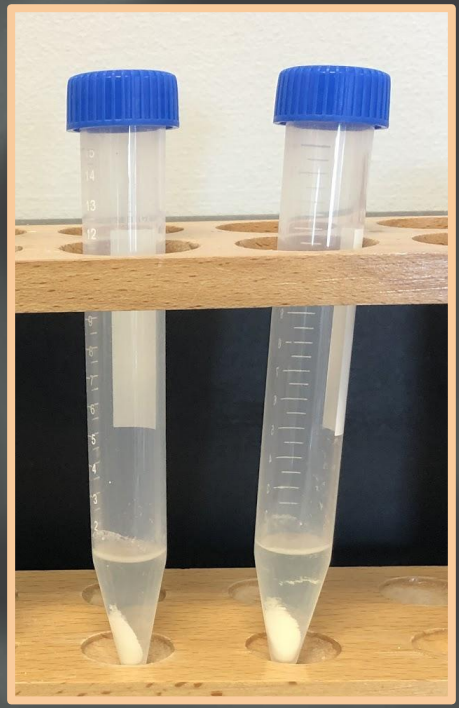
Methods

Research Design

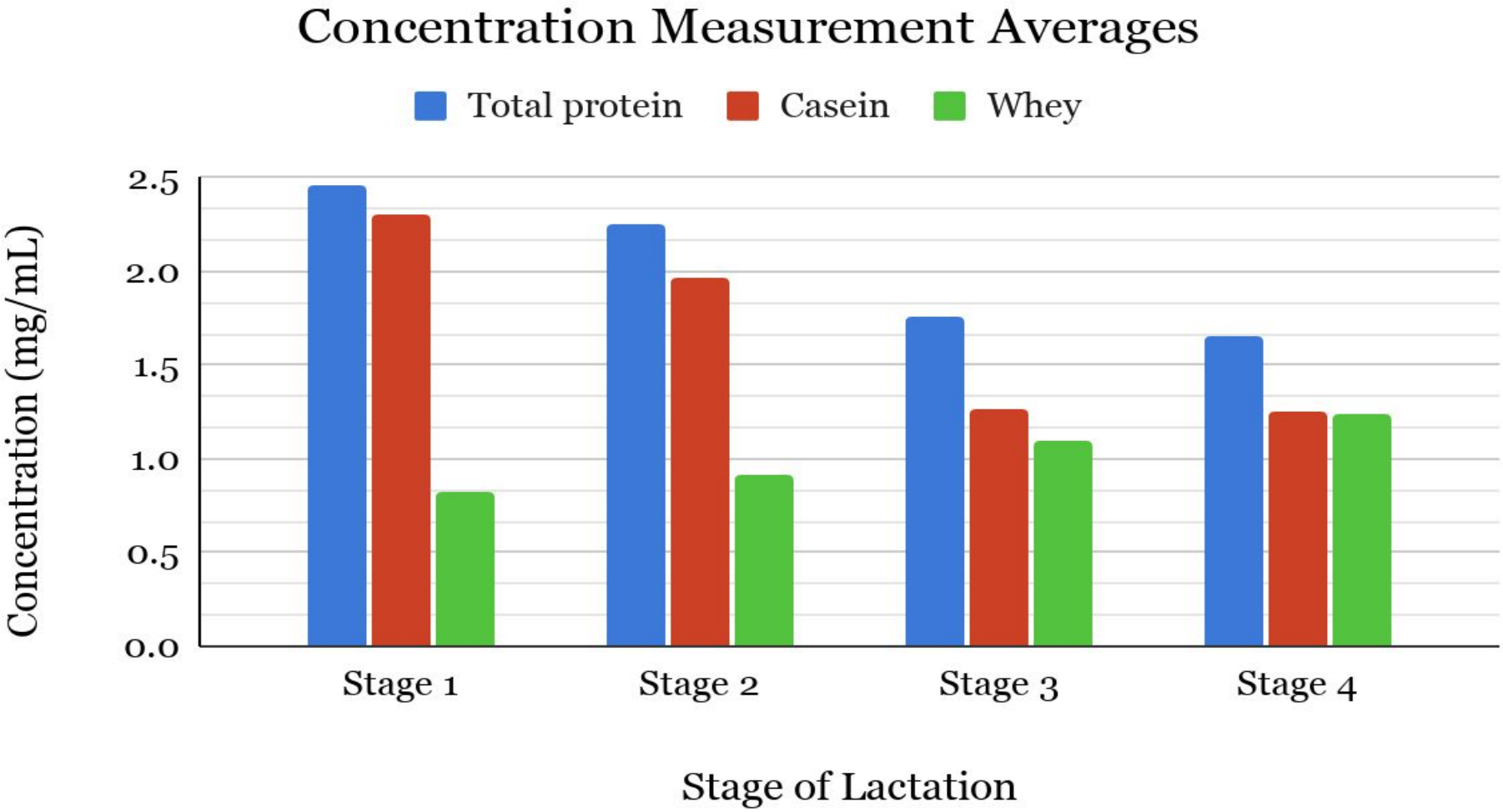
- Independent variable: stage of lactation
- Dependent variable: protein concentration measured in mg/mL
- Important materials: PASCO wireless spectrometer

Procedure

- ➔ Construct a standard curve using BSA protein standards of known concentrations.
- ➔ Prepare the whole milk samples for testing.
- ➔ Centrifuge the remaining whole milk samples to make the casein and whey proteins accessible for testing.
- ➔ Place the samples in the spectrometer to obtain absorbance readings.



Results and Conclusions


Concentration Measurement Averages
Total protein
Casein
Whey
Concentration (mg/mL)
2.5
2.0
1.5
1.0
0.5
0.0
Stage 1
Stage 2
Stage 3
Stage 4
Stage of Lactation

Conclusion

- Possible explanations for the trends observed
  - Casein is specific to the nurturing of young calves.
  - Lactoferrin confers disease resistance at the end of lactation.

Discussion

- Limitations
  - Difficulty of extracting casein protein
  - Ambiguity of time frames established for the stages of lactation
  - Samples were collected from only one cow

Directions for Future Research

- ➔ Case studies
- ➔ Experimental restriction of the synthesis of whey protein
- ➔ Changes in marketing practices

References

Bower, Julie. “Spectrometer.” Chemistry LibreTexts, Libretexts, 15 August 2020, chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Instrumental_Analysis/Spectrometer.

“Bradford Test for Protein: How Can the Protein Concentration of Milk Be Determined?” 2 October 2013. PDF file.

References

Gellrich, K., et al. “Composition of Major Proteins in Cow Milk Differing in Mean Protein Concentration during the First 155 Days of Lactation and the Influence of Season as Well as Short-Term Restricted Feeding in Early and Mid-Lactation.” *Czech Journal of Animal Science*, vol. 59, no. No. 3, 2014, pp. 97–106., doi:10.17221/7289-cjas.

“Interpreting a Standard Curve.” Spectrophotometry & Dilutions, www.nku.edu/~whitsonma/Bio150LSite/Lab%202%20Water/SpectrophotometryII.html.

References

Jabed, Anower, et al. “Targeted MicroRNA Expression in Dairy Cattle Directs Production of β-Lactoglobulin-Free, High-Casein Milk.” *Proceedings of the National Academy of Sciences of the United States of America*, vol. 109, no. 42, 2012, pp. 16811–16816. *JSTOR*, www.jstor.org/stable/41763443. Accessed 11 February 2021.

“Lactose Intolerance: MedlinePlus Genetics.” *MedlinePlus*, U.S. National Library of Medicine, 18 August 2020, medlineplus.gov/genetics/condition/lactose-intolerance/.

Thank You!