# Characterisation of major nutrients, physical properties and antimicrobial enzymes of Australian camel milk

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## Introduction

Camel milk has long been believed to offer significant health benefits, as it[1]:

- Reduces allergic reactions
- Is rich in bioactive compounds
- Is easy to digest
- Contains more iron, vitamin C and less fat
- Potentially helps in preventing diabetes and boosts immune system

Dromedary camels were imported into Australia in the 19th century, for transportation, and were later released into the wild where then they flourished. Now Australia has a significant feral population of dromedary camels, estimated in 2019 to be around 1.2 million and doubling every 8-9 years[2].


This study aims at providing a better understanding of the nutritive qualities of Australian camel milk and extending previous findings of camel milk composition from different parts of the world.

## Methods

Major nutrients analysed:

- Fat, protein, lactose, calcium, total solids and ash content

Antimicrobial enzymes analysed:

- Xanthine oxidase
- Polyamine oxidase
- Lactoperoxidase

Physical properties analysed:

- pH, viscosity, particle size distribution

Influential factors:

- Seasonal change (spring, summer, autumn and winter)
- Milking frequency (morning and afternoon)
- Milking yield (high, medium and low)

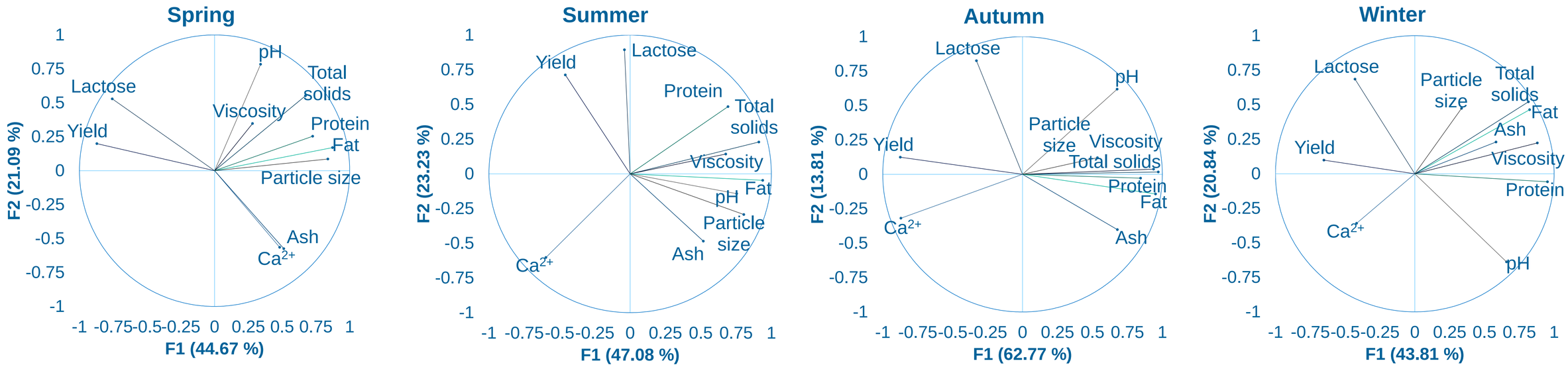
## Results

**Change in major nutrients and physical properties of Australian camel milk over the four seasons:**

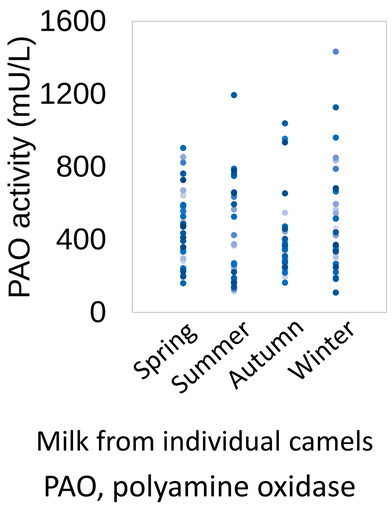
| Morning | Spring | Summer | Autumn | Winter |
|---|---|---|---|---|
| Fat, % m/v | 2.98 ± 0.43$^{a}$ | 1.99 ± 0.04$^{a}$ | 2.03 ± 0.10$^{a}$ | 2.53 ± 0.10$^{a}$ |
| Protein, % m/m | 2.89 ± 0.07$^{a}$ | 2.78 ± 0.09$^{a}$ | 2.90 ± 0.03$^{a}$ | 2.97 ± 0.07$^{a}$ |
| Lactose, % m/m | 4.79 ± 0.01$^{a}$ | 4.58 ± 0.00$^{b}$ | 4.46 ± 0.06$^{bc}$ | 4.31 ± 0.05$^{c}$ |
| $Ca^{2+}$, ppm | 97 ± 4$^{b}$ | 118 ± 5$^{a}$ | 115 ± 4$^{ab}$ | 110 ± 5$^{ab}$ |
| Ash, % m/m | 0.82 ± 0.01$^{a}$ | 0.82 ± 0.01$^{a}$ | 0.84 ± 0.00$^{a}$ | 0.83 ± 0.01$^{a}$ |
| Total solids, % m/m | 11.13 ± 0.18$^{a}$ | 9.92 ± 0.08$^{c}$ | 10.10 ± 0.07$^{bc}$ | 10.59 ± 0.12$^{ab}$ |
| pH | 6.51 ± 0.03$^{a}$ | 6.44 ± 0.03$^{ab}$ | 6.37 ± 0.03$^{b}$ | 6.38 ± 0.01$^{b}$ |
| Viscosity, mPa.s | 2.70 ± 0.10$^{a}$ | 2.54 ± 0.09$^{a}$ | 2.50 ± 0.06$^{a}$ | 2.55 ± 0.15$^{a}$ |
| Particle size, µm | 3.06 ± 0.07$^{a}$ | 2.29 ± 0.08$^{c}$ | 2.53 ± 0.04$^{bc}$ | 2.75 ± 0.17$^{ab}$ |

| Afternoon | Spring | Summer | Autumn | Winter |
|---|---|---|---|---|
| Fat, % m/v | 4.09 ± 0.24$^{a}$ | 2.78 ± 0.05$^{c}$ | 3.43 ± 0.05$^{b}$ | 3.89 ± 0.09$^{ab}$ |
| Protein, % m/m | 2.93 ± 0.11$^{a}$ | 2.79 ± 0.09$^{a}$ | 3.09 ± 0.13$^{a}$ | 3.01 ± 0.04$^{a}$ |
| Lactose, % m/m | 4.52 ± 0.05$^{a}$ | 4.33 ± 0.06$^{ab}$ | 4.28 ± 0.05$^{ab}$ | 4.13 ± 0.05$^{b}$ |
| $Ca^{2+}$, ppm | 92 ± 2$^{a}$ | 100 ± 2$^{a}$ | 103 ± 5$^{a}$ | 101 ± 2$^{a}$ |
| Ash, % m/m | 0.83 ± 0.01$^{a}$ | 0.81 ± 0.00$^{a}$ | 0.83 ± 0.00$^{a}$ | 0.81 ± 0.01$^{a}$ |
| Total solids, % m/m | 12.10 ± 0.35$^{a}$ | 10.42 ± 0.20$^{b}$ | 11.23 ± 0.09$^{ab}$ | 11.77 ± 0.08$^{a}$ |
| pH | 6.56 ± 0.03$^{a}$ | 6.50 ± 0.02$^{ab}$ | 6.42 ± 0.02$^{bc}$ | 6.40 ± 0.02$^{c}$ |
| Viscosity, mPa.s | 3.31 ± 0.47$^{a}$ | 2.50 ± 0.15$^{a}$ | 2.48 ± 0.08$^{a}$ | 2.50 ± 0.03$^{a}$ |
| Particle size, µm | 3.27 ± 0.09$^{a}$ | 3.03 ± 0.16$^{a}$ | 2.99 ± 0.06$^{a}$ | 3.17 ± 0.26$^{a}$ |

**Correlation circle of the variables:**

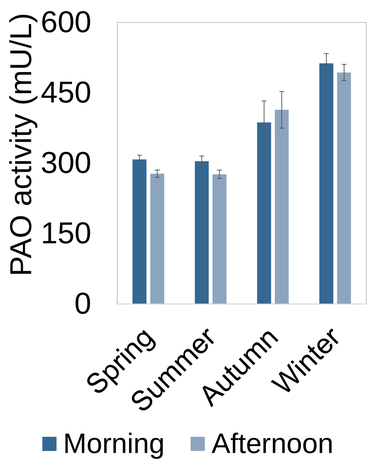


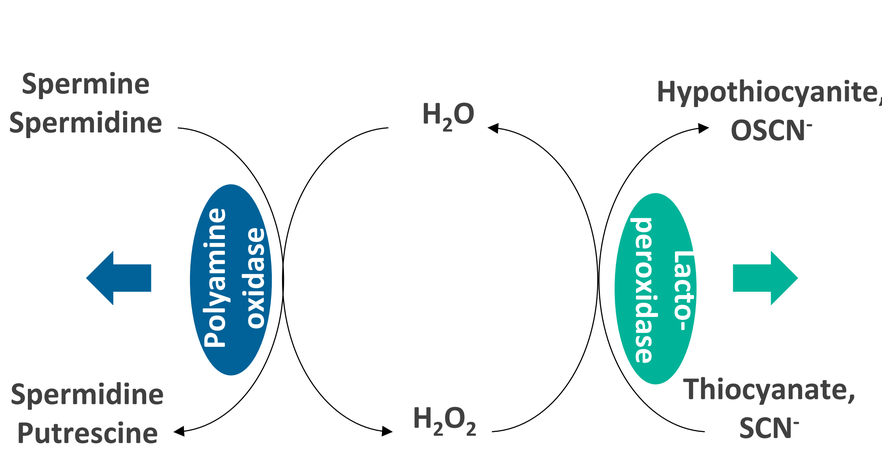

**Antimicrobial enzymes:**

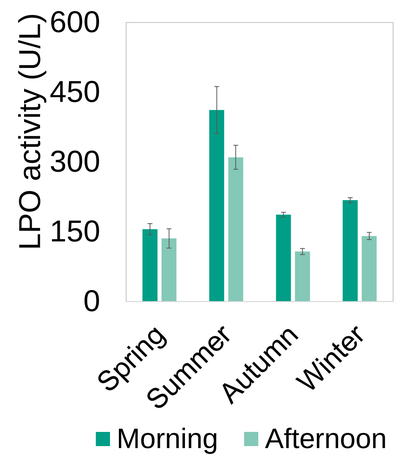


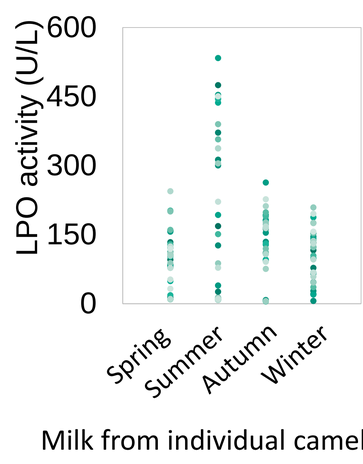

Milk from individual camels

PAO, polyamine oxidase




Milk from individual camels

LPO, lactoperoxidase

## Conclusions

- The composition and physical properties of Australian camel milk varied with season, milking frequency and yield.
- Higher content of fat, total solids and lactose was observed in spring samples compared to other seasons, while no significant ($P<0.05$) difference was found for protein and ash content among the four seasons.
- Lactose content was always positively correlated to milk yield for the four seasons, while fat, protein, total solids and ash content as well as particle size and viscosity were generally inversely correlated to milk yield.
- The highest lactoperoxidase and polyamine oxidase activities were observed in summer and winter samples, respectively, over the year. A synergistic action of the antimicrobial enzymes polyamine oxidase and lactoperoxidase in generating the potent antibacterial hypothiocyanite may exist in the camel milk.

## References

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