

# Determination of Menaquinones in Swiss Cheese Varieties

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## Introduction

Vitamin K was discovered in connection with its key role in blood clotting. Today, its importance in bone and cardiovascular health or anti-inflammatory response is recognized and increasingly researched. The microbial origin of vitamin K2 (MK-n) highlights fermented foods as a source for this nutrient, including cheese. It has been assessed in some varieties of cheese, but data are limited and do not account for factors like seasonality that affect MK-n.

## Material and methods

To investigate variation of MK-n content in cheese, we assayed 121 cheese samples from 10 cheese varieties made from cows', goats', and ewes' milk throughout an entire production year. The concentrations of menaquinone species MK-4 to MK-10 were determined using high performance liquid chromatography (HPLC).

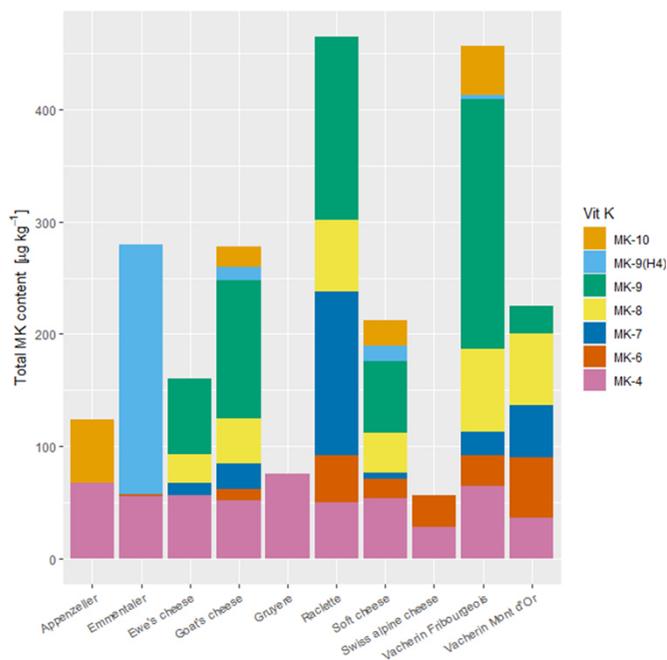
## Results

The highest average vitamin K2 content was found in Raclette (465 µg/kg), Vacherin Fribourgeois (456 µg/kg) and Emmentaler (280 µg/kg). Gruyère and alpine cheese

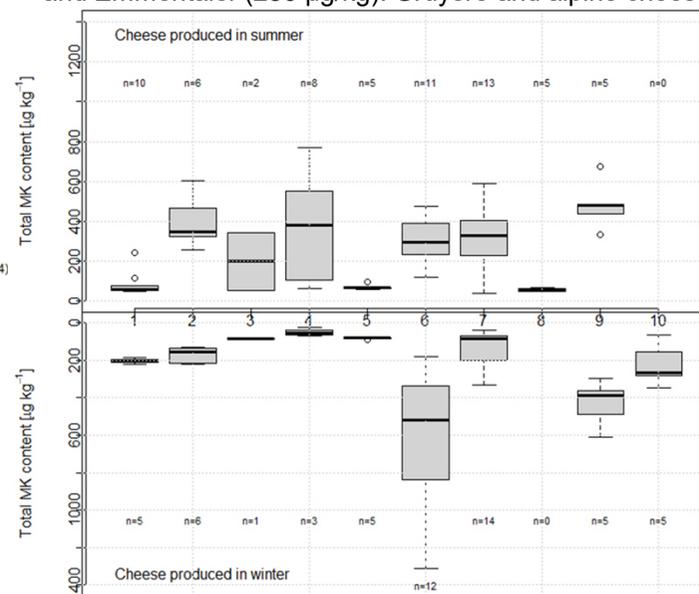
contained the lowest levels. The highest total MK content in an individual cheese loaf was 1312 µg kg<sup>-1</sup> in a three-month-old Raclette cheese from winter production.

The lowest MK content was determined in a soft cheese loaf from winter goats' milk with 23 µg kg<sup>-1</sup>. The total MK content varied greatly between summer and winter in individual loaves of the same cheese variety, even from the same cheese producer.

Despite the lipophilicity of vitamin K, we found a negative correlation between fat content ( $r = -0.35, p < 0.001$ ) and total MK content among all cheese varieties, and a positive correlation ( $r = 0.31, p < 0.001$ ) with water content.



**Figure 1.** Sum of the mean concentrations of the individual menaquinone species (MKs) found in 10 different Swiss cheese varieties.



**Figure 2.** Total menaquinone content of 10 different Swiss cheese varieties from summer and winter production.

1. Appenzeller
2. Emmentaler
3. Ewe's milk
4. Goats' milk
5. Gruyère
6. Raclette
7. Soft
8. Swiss alpine
9. Vacherin Fribourgeois
10. Vacherin Mont d'Or

## Summary & Key Findings

- We assayed 121 cheese samples from 10 cheese varieties made from cows', goats', and ewes' milk throughout an entire production year for their MK-4 to MK-10 content using HPLC.
- Seasonal variability was observed for some cheese varieties, while fat content negatively correlated with total MK-n.
- MK-n in the cheese ranged from 23 to 1312 µg kg<sup>-1</sup>
- The main determinant of MK-n content were the bacterial strains used in the starter cultures.
- Scalding temperature strongly influenced MK-n content by affecting the survival of MK-n-producing strains like lactococci, leuconostoc and propionibacteria.
- Based on our results, in Switzerland, 13 to 17% of the recommended daily intake for Vitamin K is met by cheese consumption.