# COMPARISON OF PHYSICO-CHEMICAL PROPERTIES OF HUMAN NAIL AND BOVINE HOOF

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## INTRODUCTION

Bovine hoof membranes are currently used as a model for the human nail [(1)], due to the limited availability of nail plates and the similarities between the two structures. In fact, both are keratinic tissues where keratins exist predominantly in an α-helical conformation[(2)]. In addition, hoof membranes have been shown to be suitable models for nail plates in transungual permeation experiments [(3)].

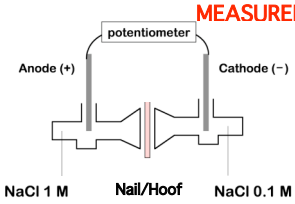
**Purposes of this work are:**

**-To characterize human nail and bovine hoof membrane in terms of permselectivity, in view of the application of transungual iontophoresis.**

**-To measure human nail and bovine hoof membrane swelling capacity, and partition of two model compounds (caffeine and propylparaben).**

## METHODOLOGY

### MEASUREMENT OF $Na^+$ TRANSPORT NUMBER [(4)]




- Human nail (1 mm thick) and bovine hoof membrane (200-400$\mu$m thick)
- pH values of NaCl solutions: from 2 to 8.5, HEPES buffer
- silver/silver chloride electrodes

$$t_{Na} = 0.5 + \frac{FV_m}{2RT\ln\frac{C_2}{C_1}}$$

$V_m = V_{measured} - V_{electrodes}$

*$V_m$= membrane potential (V)*
*R = Gas constant (J mol$^{-1}$ Kelvin$^{-1}$)*
*T = Absolute temperature (Kelvin)*
*F = Faraday's costant (96478 C/mol).*

### MEASUREMENT OF MODEL COMPOUNDS' PARTITION COEFFICIENTS

| MOLECULAR CHARACTERISTICS | CAFFEINE | PROPYLPARABEN |
|---|---|---|
| MW | 194.19 | 180.2 |
| LogP Oct/$H_2O$ | -0.07 | 2.81 |
| Water solubility (mg/ml) | 20 | 0.37 |

$$\text{Partition Coefficient} = \frac{[C_{nail/hoof}]}{[C_{water}]} * \frac{V_{water}}{V_{nail/hoof}*}$$

- Human nail or bovine hoof weighted amount (50-100 mg)
- Aqueous solution of the model compounds (≈100$\mu$g/ml)
- 6 days equilibration
- HPLC analysis of the water solution

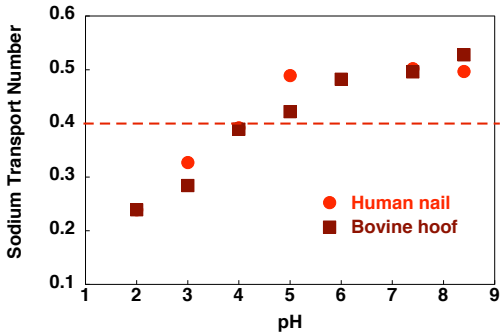
* *Estimated , considering the nail/hoof density equal to 1*

### NAIL AND HOOF SWELLING

The nail/hoof swelling was measured after 6 days of immersion in distilled water, as percent weight increase.

## RESULTS

### HUMAN NAIL AND BOVINE HOOF ISOELECTRIC POINT




Sodium transport number ($t_{Na+}$) depends on membrane charges, i.e. depends on pH and on nail/hoof isoelectric point.
For a neutral membrane it is 0.4

**The isoelectric point of both human nail and bovine hoof membrane is approximately 4 (where $t_{Na+}$ assume the value of 0.4)**
**They are negatively charged at physiological pH**

### NAIL/WATER AND HOOF/WATER PARTITION COEFFICIENTS

| | CAFFEINE | PROPYLPARABEN |
|---|---|---|
| Log P HUMAN NAIL/Water | 1.14±0.12 | 2.27±0.01 |
| Log P BOVINE HOOF/Water | 1.45±0.15 | 2.35±0.11 |

The partition of caffeine and propylparaben was similar in the case of bovine hoof membrane and human nail

### NAIL AND HOOF SWELLING

| | SWELLING (%) |
|---|---|
| HUMAN NAIL | 23 ± 7 |
| BOVINE HOOF | 38 ± 9 |

Bovine hoof membranes swelled more than human nail. This data is in good agreement with literature report [(7)].

The value of IP obtained here is lower than that reported in the literature [(5)] and obtained through the measurement of glucose flux (IP= 5)
This can be due to the inherent biological variability of nail specimens or, according to the conclusions of Pikal [(6)], to the different methods used.

## CONCLUSION

✓Bovine hoof and human nail are characterised by the same isoelectric point and both are negatively charged at physiological pH
✓Bovine hoof and human nail are characterised by a similar partition of caffeine and propylparaben.
✓The swelling capacity of bovine hoof membrane was slightly higher than that of human nail.

## REFERENCES

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