# Chemical analysis of human sweat for electrochemical properties and identification of organic compounds

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## INTRODUCTION

Extensive physical and chemical analysis on bodily sweat is scarcely present among scientific research, even though the biofluid is relatively easy to acquire and examine, due to its non-invasiveness. Used vastly to analyse its saline properties and metabolite composition, often during pre-/post-exercise investigations, sweat may increasingly become of scientific interest due to its ability to exhibit properties that reveal hidden internal conditions, whether human or of another organism. Not only does sweat have a wide range of flexibility to the degree to which it can be tested, due to its clear liquid form, but its experimental reproducibility in studies is high. Sample size is critical in producing accurate and conclusive research, to which the endless opportunities to collect sweat samples champions.

Out of pure interest and passion for human physiology, I chose to explore how far I could chemically analyse human sweat samples.

Of course, there are various drawbacks to the collection sample purity as it could interfere with substances already present on the skin, however, metabolites and compounds produced internally are significantly different to those present externally.[1] Further investigations into sweat's electrochemical properties and how it mirrors the vast physiological information underneath the human skin, could pave the way to provide an alternative and accurate method for clinical monitoring instead of blood. These studies open new opportunities to extend the applicability of human sweat as a source of metabolite biomarkers of pathologies or specific processes such as nutritional imbalance.

## METHODS

Step 1: Collection of facial sweat after vigorous exercise

Step 2: Preparation of 1M solutions of common salts for comparison ($NaCl$, $CuSO_4$, $MgSO_4$)

Step 3: Measurement of pH, and voltage of electrical cell created using salt bridge and samples

Step 4: Crystallisation of sweat samples to extract solid residue

Step 5: Qualitative light emission wavelength comparison between sweat samples and known salts (faulty laboratory spectrophotometer gauge)

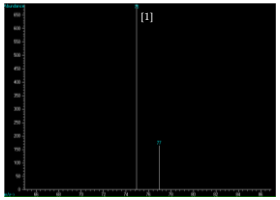
Step 6: Presence of starch and ammonium ions using iodine solution and dilute NaOH, respectively

Step 7: Separation of possible organic compounds from sweat samples using GC-MS/headspace vaporization analysis, and comparison to known compounds [2]

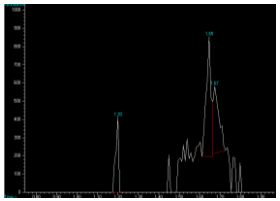
**Table 1. Analysis of Sweat**

| | *Sweat S#1* | *Sweat S#2* | NaCl (aq) 1M | $MgSO_4$ (aq) 1M | $CuSO_4$ (aq) 1M |
|---|---|---|---|---|---|
| Potential Difference (V) | 0.197 | 0.364 | 0.530 | 0.284 | 0.0600 |
| pH | 8.88 | 8.73 | 7.40 | 6.88 | 3.63 |
| | 8.88 | 8.74 | 7.37 | 7.00 | 3.67 |
| | 8.87 | 8.71 | 7.38 | 6.93 | 3.66 |
| pH (average) | 8.88 | 8.73 | 7.38 | 6.94 | 3.65 |
| Qualitative Flame Colour | orange-yellow | orange-yellow | orange-yellow | no colour | blue-green |
| Peak Wavelength ($\lambda$/nm) | 580 | 580 | 580 | N/A | 500 |
| Presence of Starch | negative | negative | N/A | N/A | N/A |
| Presence of Ammonium Ions | positive | positive | N/A | N/A | N/A |

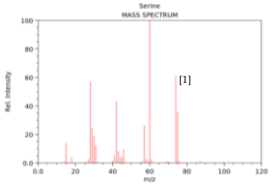
## GC-MS Graphs



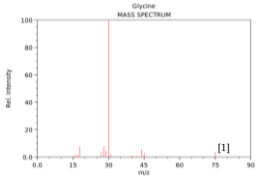
(1) Molecular ion MS peak at 75 m/z



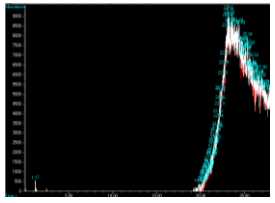
(2) GC peaks at 1.2/1.65 retention time, correspond to MS 45 m/z



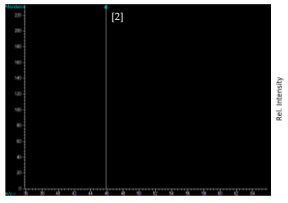

[1] Molecular ion peak at 75 m/z



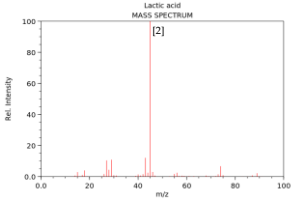

[1] Molecular ion peak at 75 m/z



(3) GC of sample




(4) Molecular ion MS peak at 46 m/z




[2] Molecular ion peak at 45-46 m/z

## CONCLUSIONS

Different volumes of sweat used explain the largely dissimilar voltages measured in the electrical cells. Closest pH value to sample is NaCl, however difference in pH value is large so may be inconclusive. Major contributor to the salt composition in sweat is Na, as colour of flame is orange-yellow. Positive blue colouration of universal indicator paper shows presence of ammonium ions , however negative orange result of iodine solution shows absence of starch. No production of visible flame colour from magnesium salt, due to high strength of nuclear attraction to outer electron.

Similar mass spectrums show possible presence of certain organic compounds (lactic acid, glycine, serine and uric acid).[3] Possible contamination from organic compounds originating from plastic sweat-collection bottle, hindered GC-MS headspace analysis results accuracy. Limited by extensiveness of mass spectrum resolution, further fragment peaks are not shown.

**References**

1. Jadoon, S., Karim, S., Akram, M., Kalsoom Khan, A., Zia, M., Siddiqi, A. and Murtaza, G., 2015. Recent Developments in Sweat Analysis and Its Applications. International Journal of Analytical Chemistry, 2015, pp.1-7.
2. NIST Mass Spectrometry Data Center, William E. Wallace, "Mass Spectra" in NIST Chemistry WebBook, NIST Standard Reference Database Number 69, Eds. P.J. Linstrom and W.G. Mallard, National Institute of Standards and Technology, Gaithersburg MD, 20899.
3. Zernecke, A.M. Kleemann, K. Haegler, J. Albrecht, B. Vollmer, J. Linn, H. Brückmann, M. Wiesmann, Chemosensory Properties of Human Sweat, Chemical Senses, Volume 35, Issue 2, February 2010, Pages 101–108.