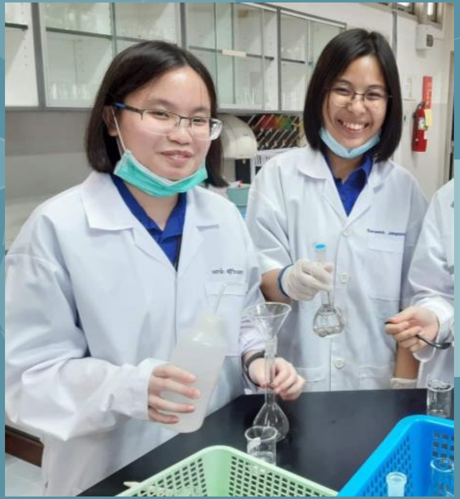
Citrate detection in Urine by Colorimetric Paper-based Sensor for Screening of Prostate cancer



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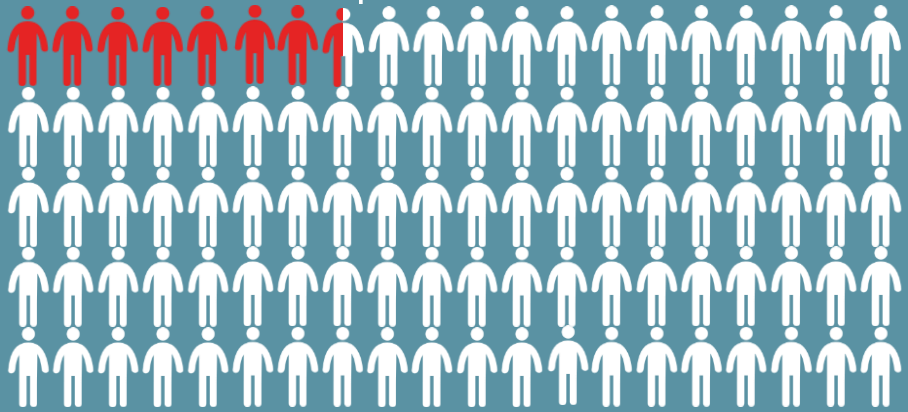
INTRODUCTION

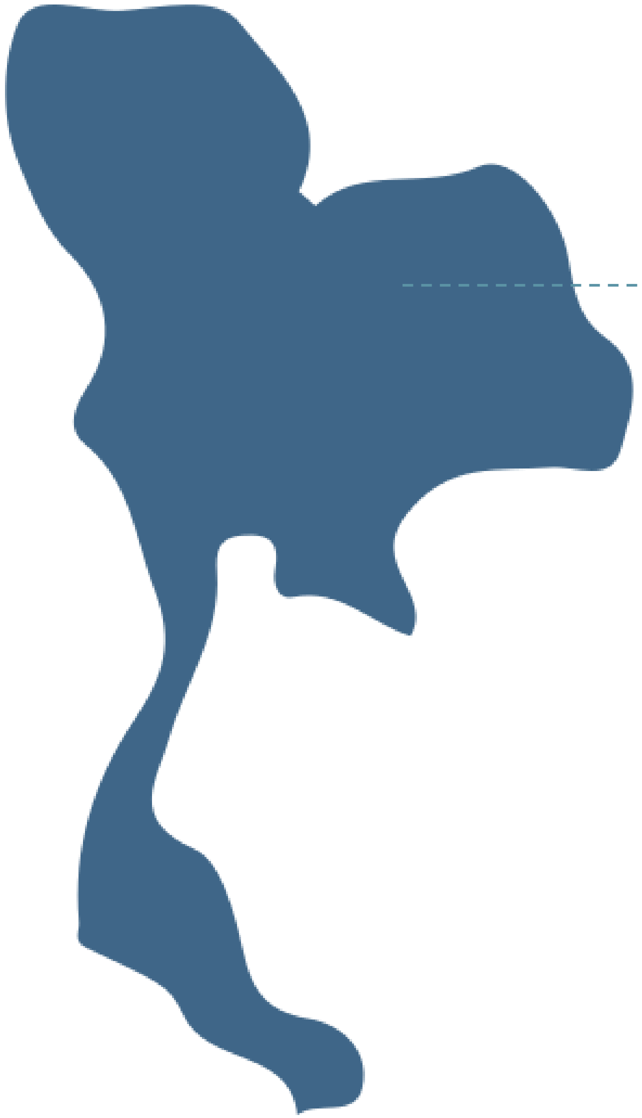
Percentage of Prostate Cancer patients



2018

(National Cancer Institute, Bangkok, Thailand, 2018)

Introduction



- 4th most common cancer in Thailand
- 20-50% Survival rate (5 years cumulating)
- 50% of Men over 80 years old
- gradual increase

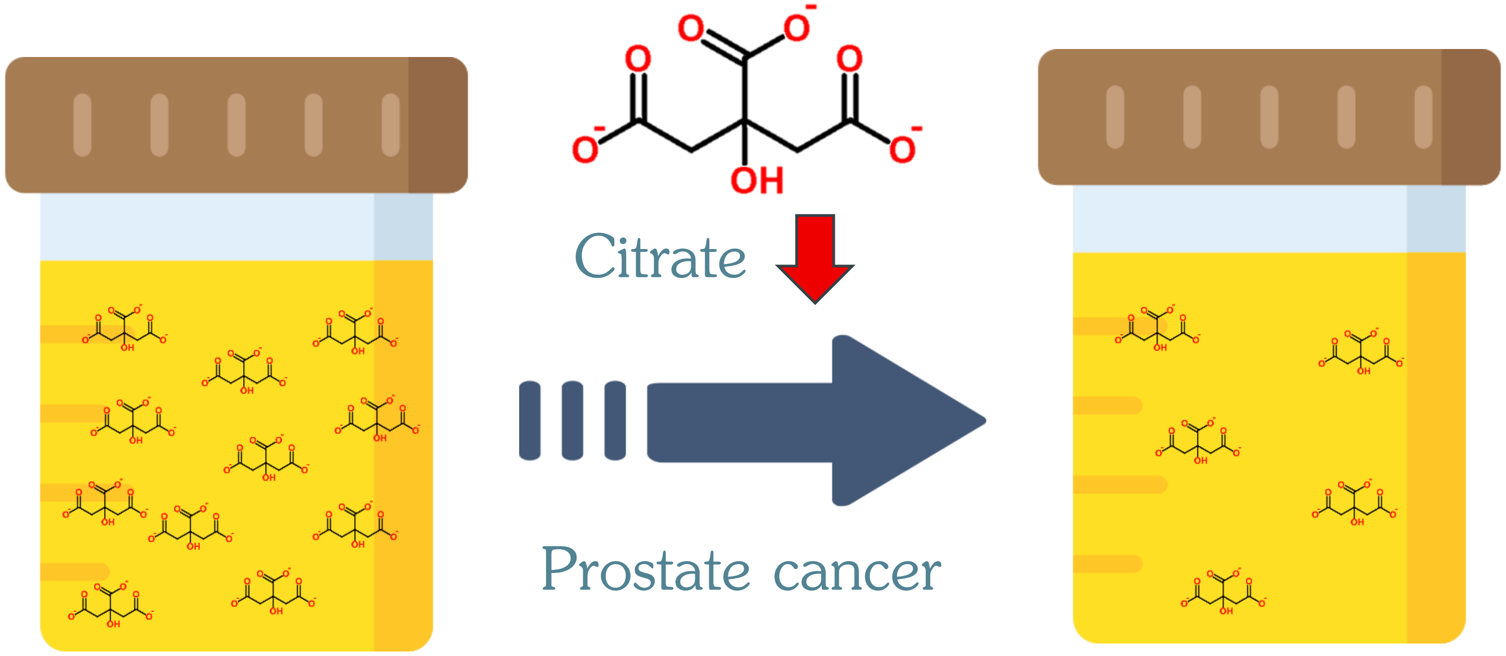
(MedThai, 2017)

Symptoms of prostate cancer

- ☑ pee more frequently, often during the night 
- ☑ rush to the bathroom 
- ☑ difficulty in starting to pee (hesitancy) 
- ☑ strain or take a long time while peeing 

(NHS, 2018)

Citrate in Urine

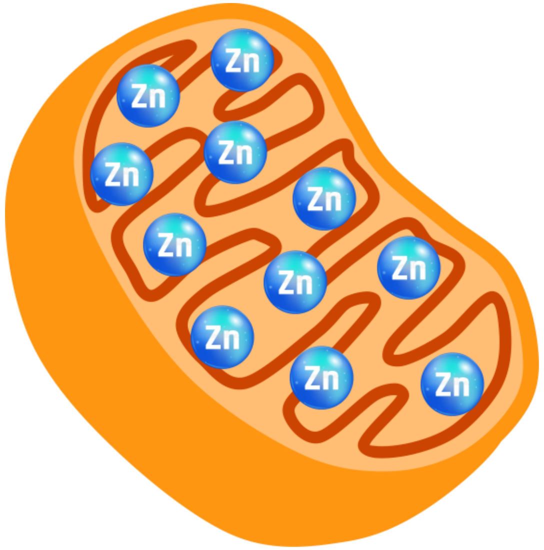


9.5 mM

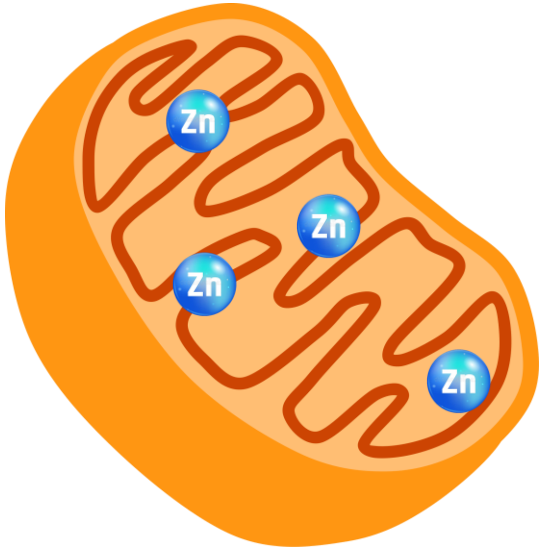
6.9-2.4 mM

(Silva, et al., 2012)

A decrease in the level of citrate



Normal



With cancer

(Costello, & Franklin, 1998)

A decrease in the level of citrate

Normal

Aconitase Enzyme

Citrate Oxidation

Krebs Cycle

With cancer

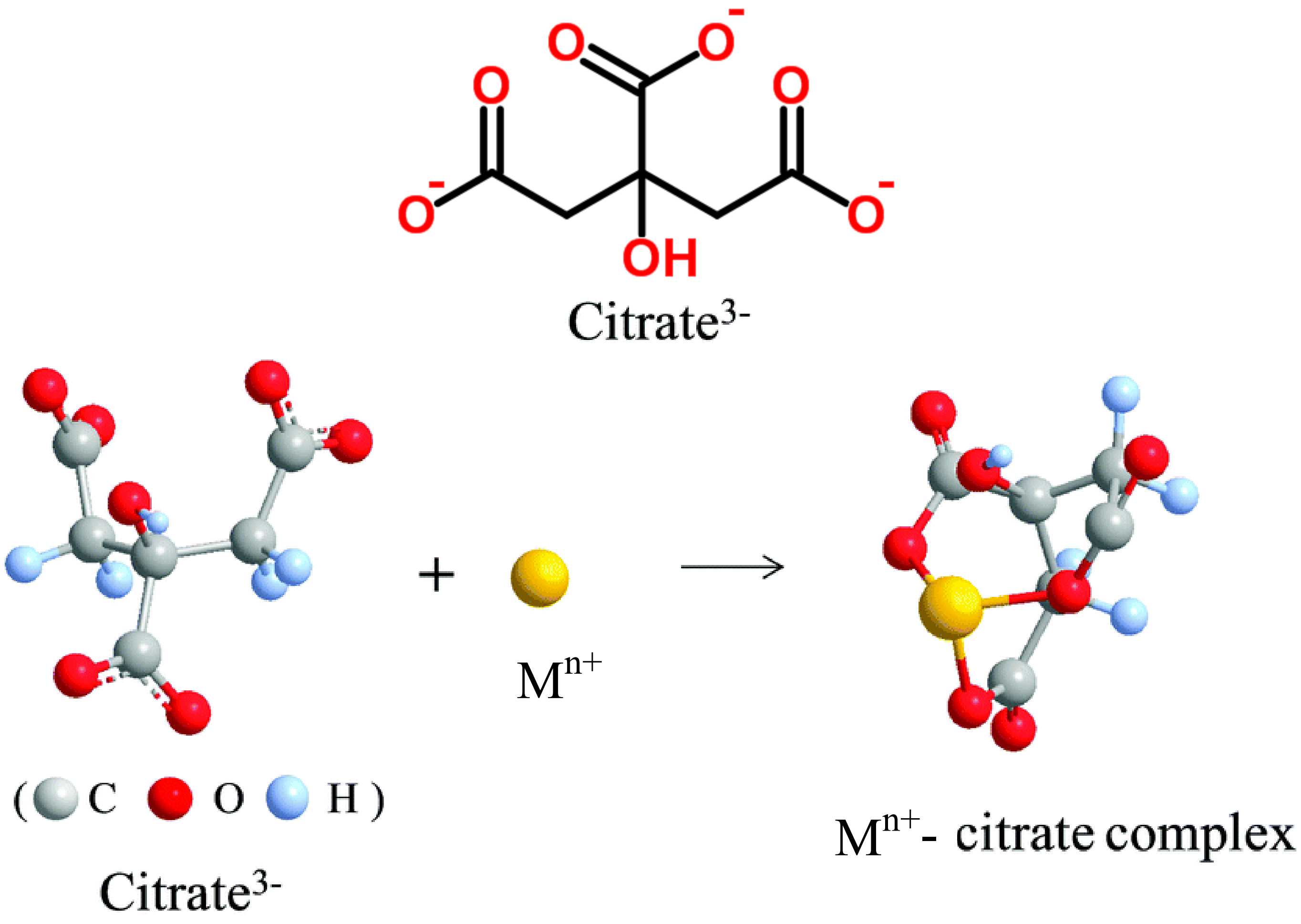
Aconitase Enzyme

Citrate Oxidation

Disorder of Krebs Cycle

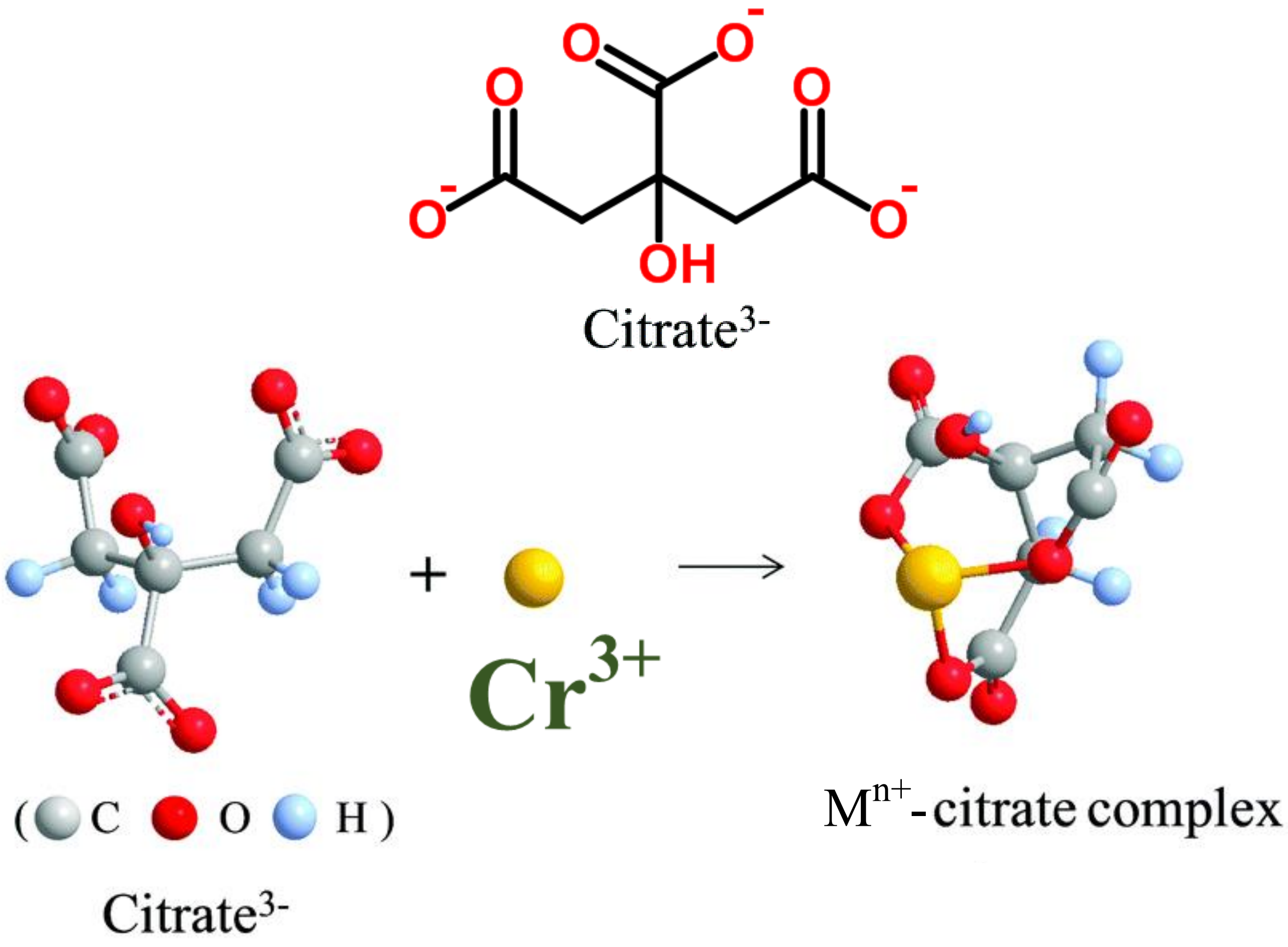
(Costello, & Franklin, 1998)

Color from Complexs



(Gautier-Luneau et al., 2005)

CITRATE COMPLEXS WITH METALS



(Gautier-Luneau et al., 2005)

Finding Mole Ratio of the compound

$Cr(NO_3)_3$ 10 mM

Citrate 10 mM

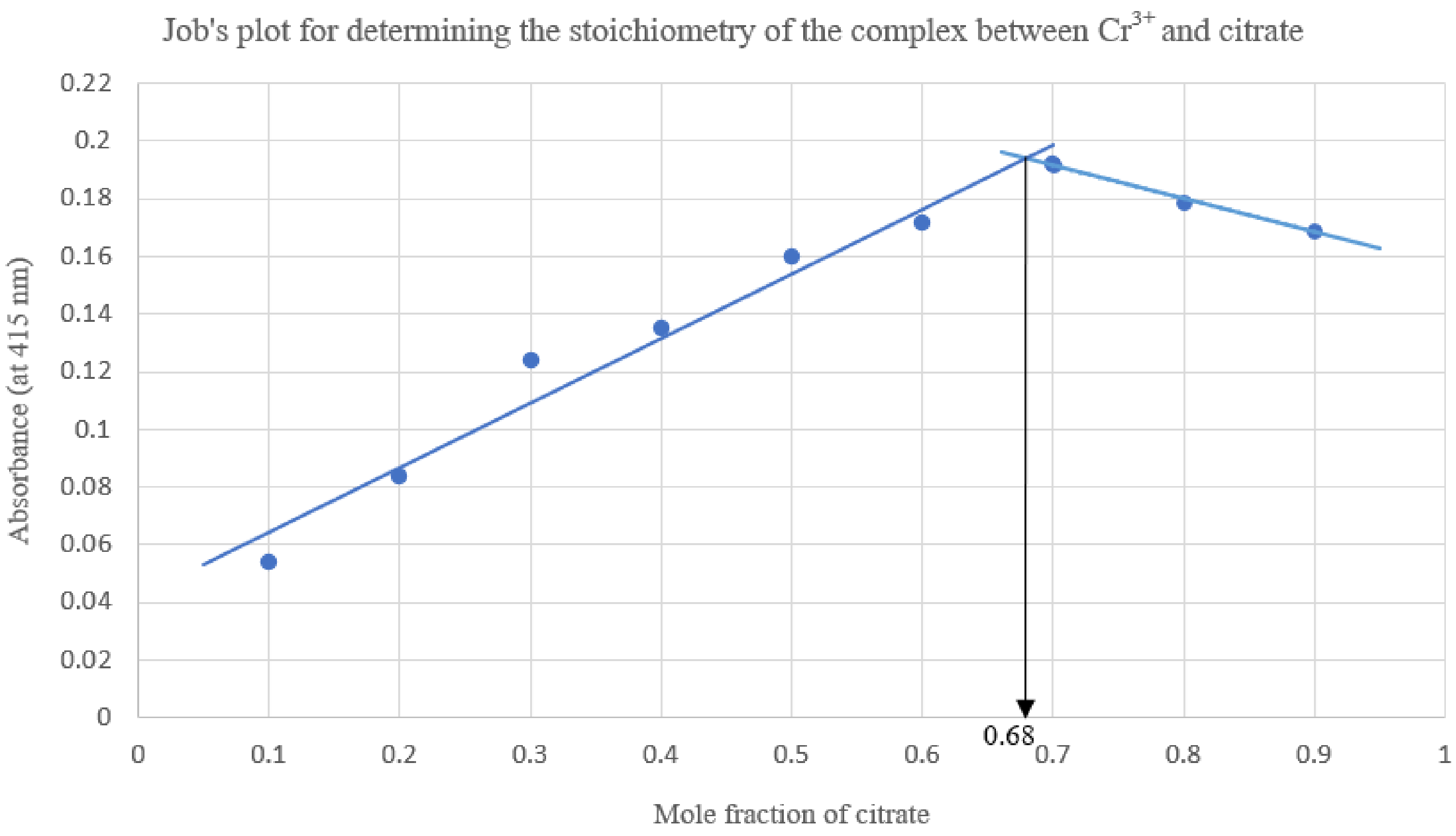
? µL

? µL

Solutions	Volume of Citrate 10 mM (µL)	Volume of Cr^{3+} 10 mM (µL)
1	300	2700
2	600	2400
3	900	2100
4	1200	1800
5	1500	1500
6	1800	1200
7	2100	900
8	2400	600
9	2700	300

Finding Mole Ratio of the compound

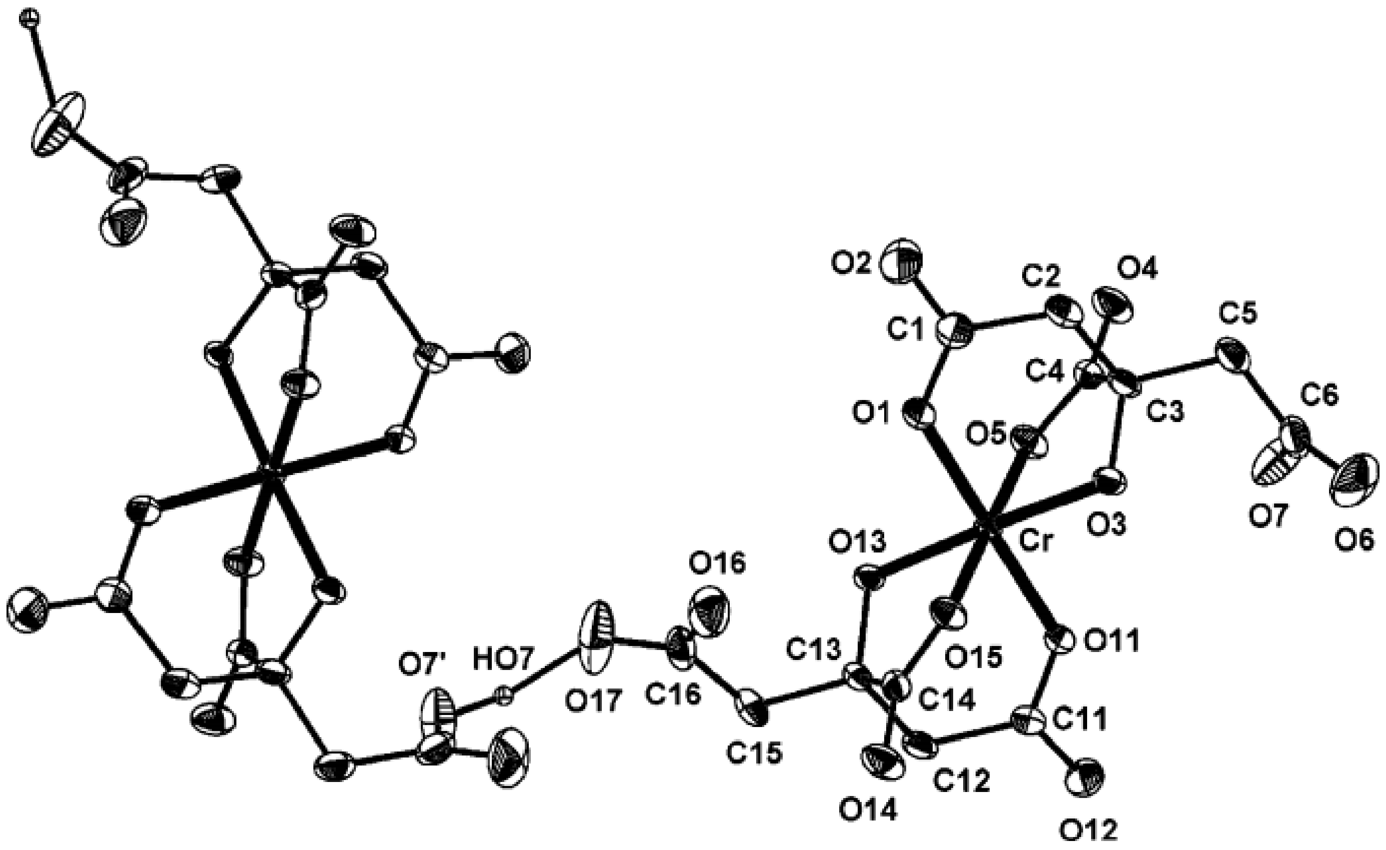
Job's plot



Cr^{3+} : Citrate

1 : 2

Finding Mole Ratio of the compound



ORTEP structure of the

[Cr(C6H4O7)(C6H5O7)] 4-anion

(Gabriel et al., 2007)

Testing varied concentration of citrate in DI water

3, 6, 9, 12, 15, 18,
21, 24, 27, 30

$Cr(NO_3)_3$

1.5 mL

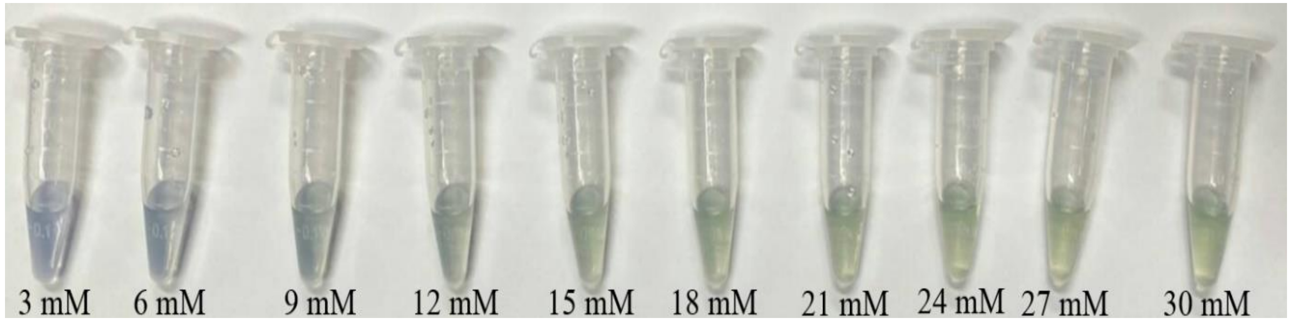
+

Citrate ? mM

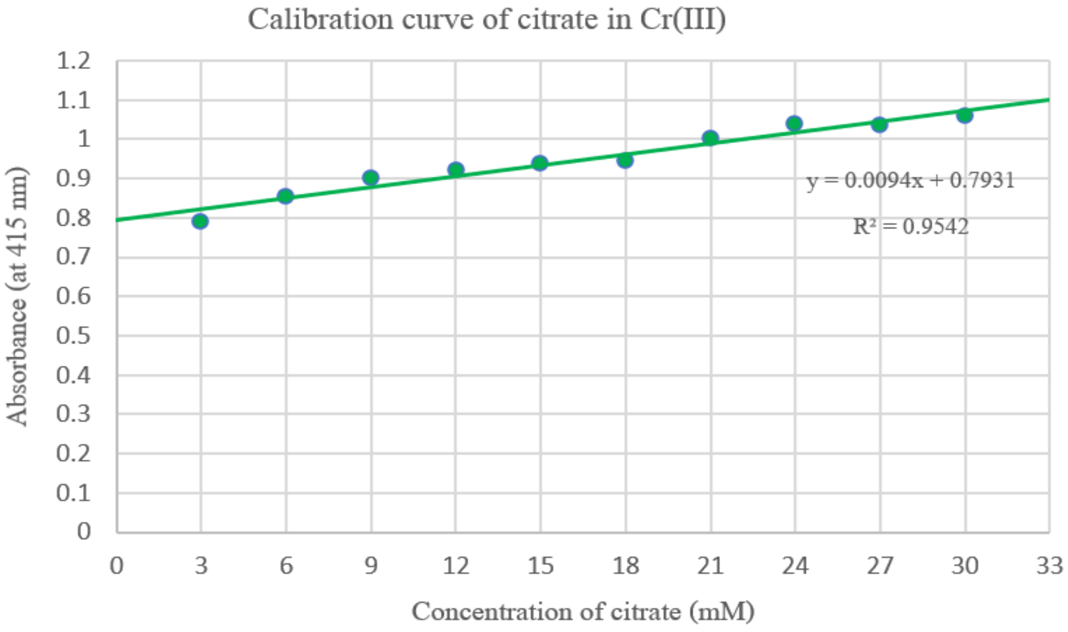
1.5 mL

Testing varied concentration of citrate in DI water

Experiment in DI water

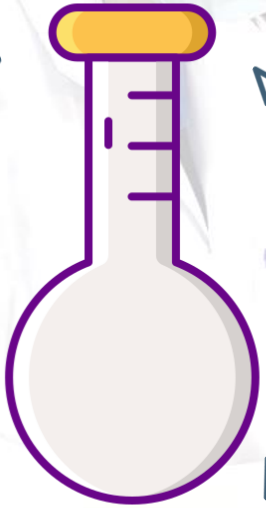


Citrate Concentration



Preparation of Artificial Urine

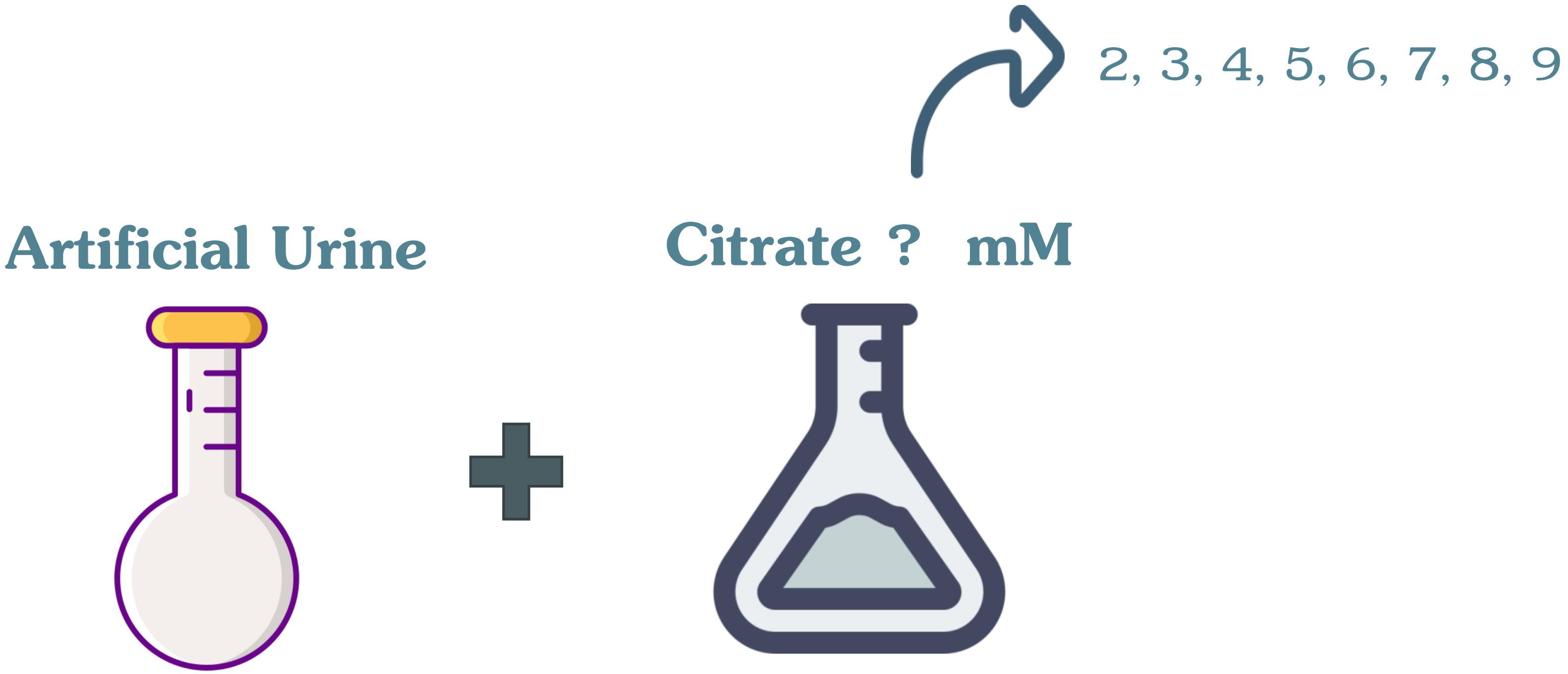
- (0.650 g) $Na_3C_6H_5O_7$
- (4.600 g) $NaCl$
- (0.651 g) $CaCl_2$
- (0.651 g) $MgCl_2$
- (1.600 g) KCl
- (2.800 g) KH_2PO_4



- $C_4H_9N_3O_2$ (1.100 g)
- $CO(NH_2)_2$ (25.000 g)
- Na_2SO_4 (2.300 g)
- NH_4Cl (1.000 g)
- $Na_2C_2O_4$ (0.023 g)

Artificial Urine 1 L

Experiments in Artificial Urine



Experiments in Artificial Urine

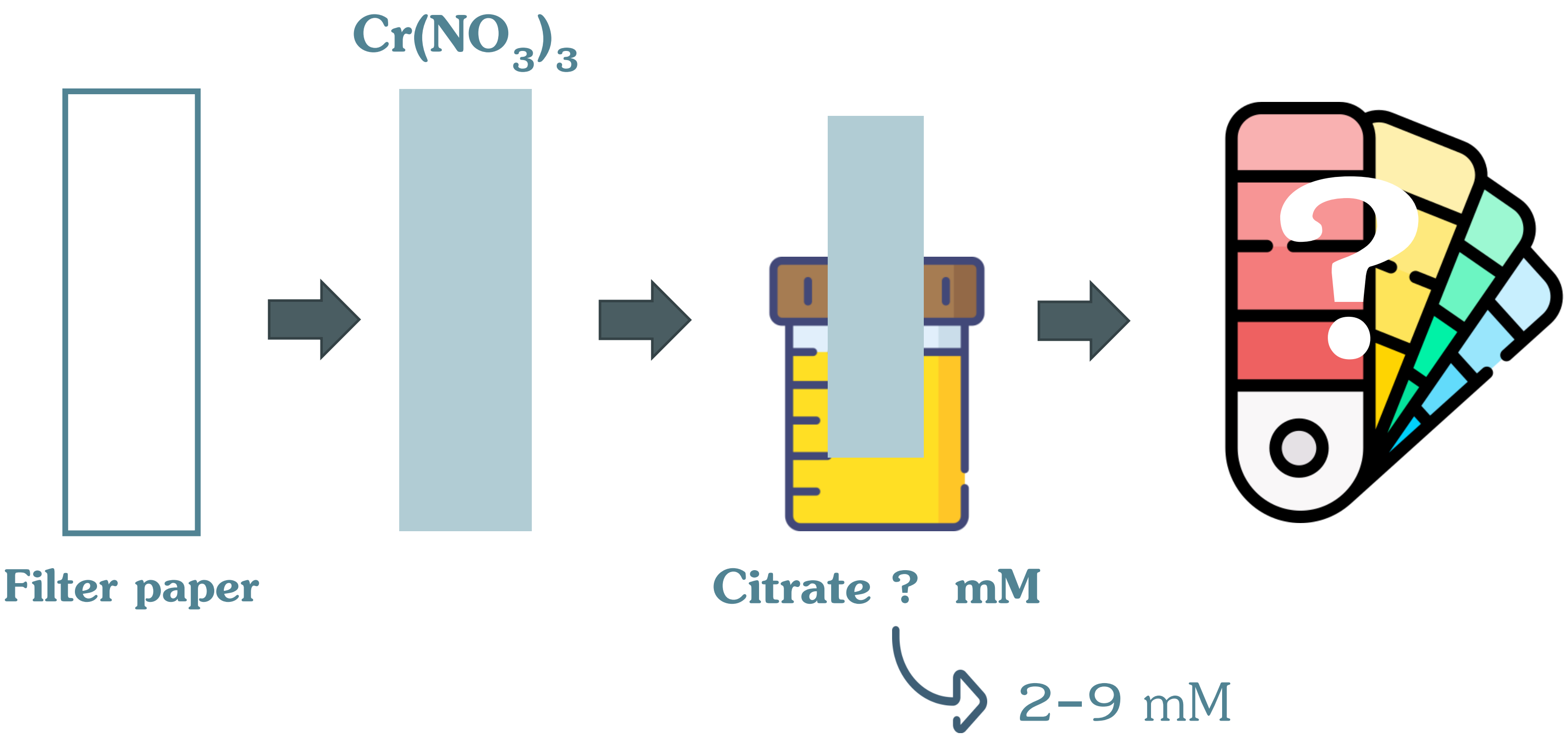
2 mM 3 mM 4 mM 5 mM 6 mM 7 mM 8 mM 9 mM

Citrate Concentration

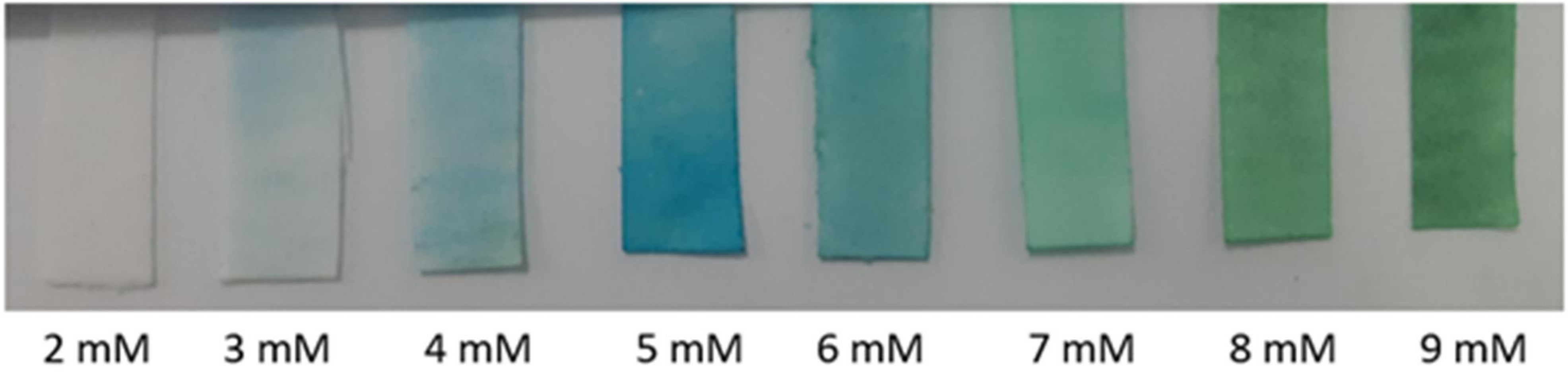
Color change of chromium(III) ions and different concentration of citrate in artificial urine

(The range covers the change of citrate concentration in human urine)

Preparation of Paper-based Sensor

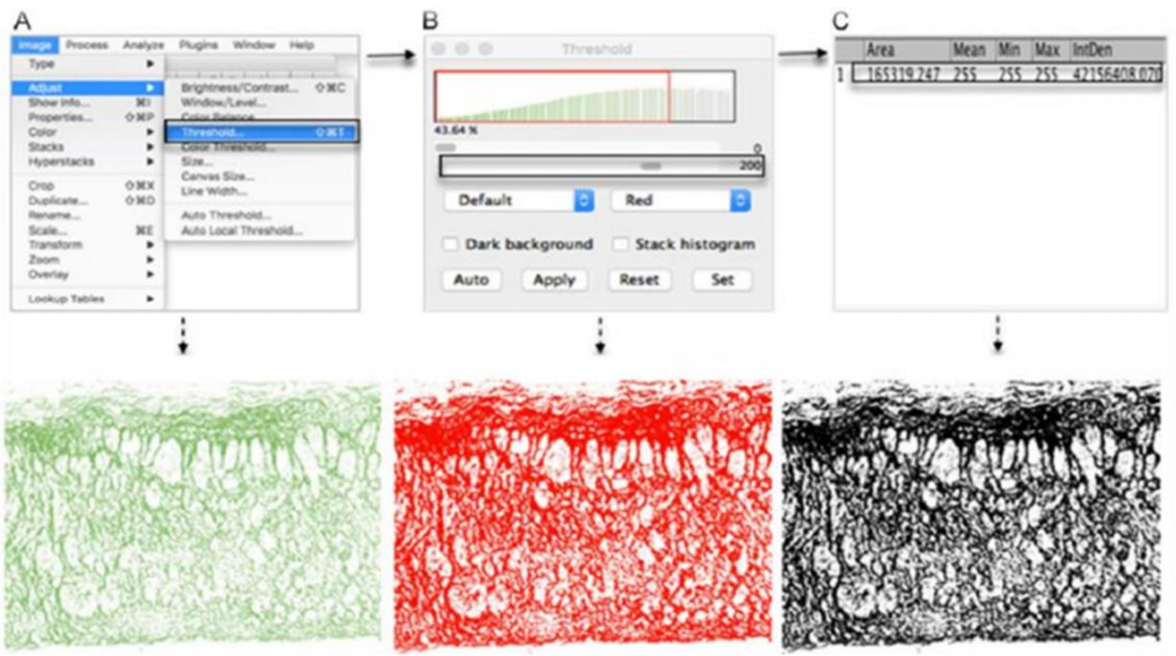


Citrate Detection by Paper-based Sensor



Low citrate → High citrate

Further Development



- Using ImageJ program to find grey value and plot calibration curve
- Making a color chart for the colorimetric paper-based sensor for simple analysis and real usage

References

Costello, L. C., & Franklin, R. B. (1998). Novel Role of Zinc in the Regulation of Prostate Citrate Metabolism and Its Implications in Prostate Cancer, 296(December 1997), 285–296.

Gautier-luneau, I., Merle, C., Phanon, D., Lebrun, C., Biaso, F., Serratrice, G., & Pierre, J. (2005). New Trends in the Chemistry of Iron (iii) Citrate Complexes : Correlations between X-ray Structures and Solution Species Probed by Electrospray Mass Spectrometry and Kinetics of Iron Uptake f rom Citrate by Iron Chelators, 2207–2219. https://doi.org/10.1002/chem.200401087

Silva, R. O., Nabeshima, C. T., Bellini, M. H., & Courrol, C. (2012). Early Diagnosis of Prostate Cancer by Citrate Determination in Urine with Europium – Oxytetracycline Complex, 66(8), 958–961. https://doi.org/10.1366/11-06546