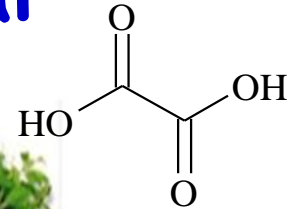
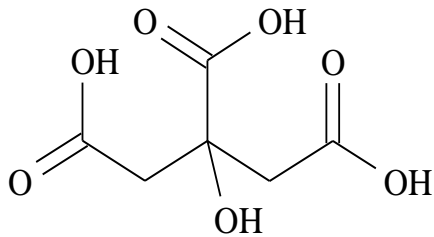


Organic acids make more sour taste than ascorbic acid in Thai indigenous plants

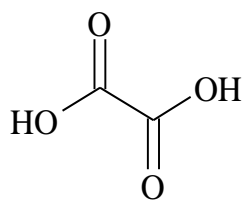


Benyathip Sukontaprapun,
Kunchit Judprasong*,
Somsri Charoenkiatkul

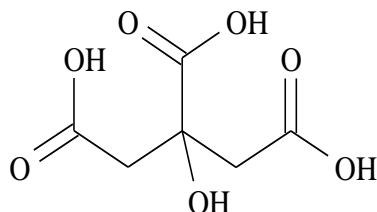
Institute of Nutrition, Mahidol University (INMU),
Phutthamonthon 4 Rd., Salaya, Phutthamonthon,
Nakhon Pathom 73170 Thailand
Email: kunchit.jud@mahidol.ac.th

Organic acids

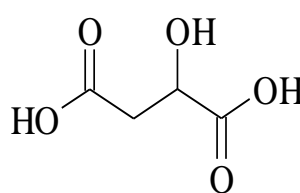
- Organic compounds have at least one carboxylic functional group (R-COOH).
- Organic acids are primary metabolites component that contributed to plant growth.
- They are found in great amount in all plants especially in vegetables and fruits and other manufacture products such as vinegar, salad dressings.



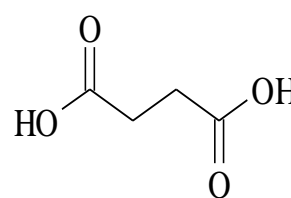
Oxalic



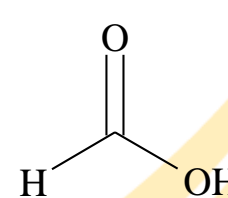
Citric



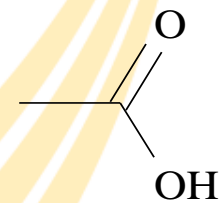
Malic



Succinic



Formic



Acetic 2

Benefits of Organic acids

- Some organic acid may be used as **indicators for ripeness** and they may also **prevent darkening and enzymatic browning** produced after cooking of potatoes (Silva et al., 1991).
- They can **stabilize vitamins B and C** and decrease possible destruction of vitamins from heat and light (Shoufeng et al., 2011).
- These organic acids can **improve mineral absorption** (Shoufeng et al., 2011).

Energy from organic acids

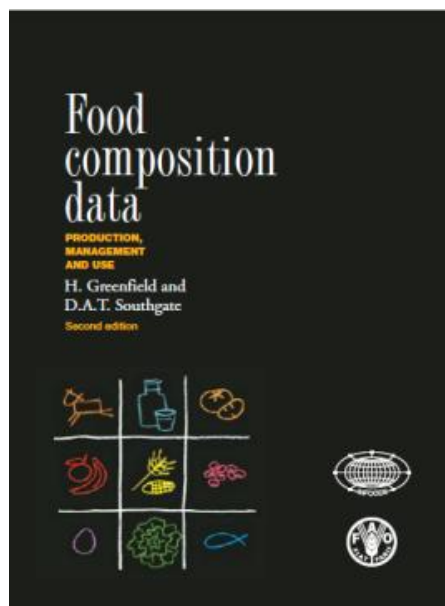
- Greenfield & Southgate book (2003) mentioned that organic acids should be included in energy calculations.
- ✓ Energy (kcal/100g) = CHO × 4 +

Fat × 9 +

Protein × 4 +

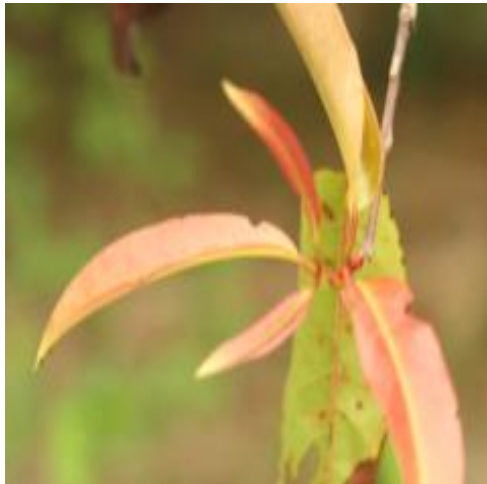
Alcohol × 7 +

Organic acid × 3



Why we are interesting in organic acid ?

- Organic acids can influence sensory properties of fruits and vegetables which could have sour and tart flavors.
- Most of indigenous plant has strong sour taste but some of them contained high vitamin C.



Vitamin C 745 mg/100g

(Charoenkiatkul S, et al.2012)

Organic acid ?

Tew-deang (Thai name)

(*Cratoxylum formosum* (Jack) Dyer):

Commonly consumed as fresh

Why we are interesting in organic acid ?

- Another indigenous plant also has strong sour taste but very low amount of vitamin C (Charoenkiatkul *et al.* 2012).



Vitamin C 1-3 mg/100g

Organic acid ?

Ma-mao (Thai name)

(*Antidesma ghaesembilla* Gaertn.):

Commonly eaten as fresh or fruit juice

- Most of people believed that if food has a sour taste, it also contained high amount of vitamin C ???



Objectives

1. To determine individual organic acid in indigenous plants collected from 2 conservative areas in Thailand.
2. To see the correlation between each organic and vitamin C contents.

Study area

Kanchanaburi province



Amnatchareon province









Material & methods



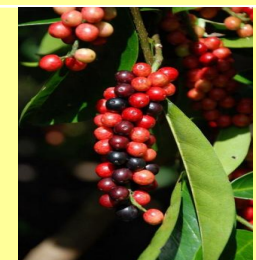
55 indigenous plants samples

- 1) 8 types of young leaves-consumed plants
- 2) 4 types of flower-consumed plants
- 3) 11 types of fruit-consumed plants
- 4) 1 type of pod-consumed plants
- 5) 3 types of tuber-consumed plants
- 6) 2 types of young stem-consumed plants

Example of young leaves-consumed plants

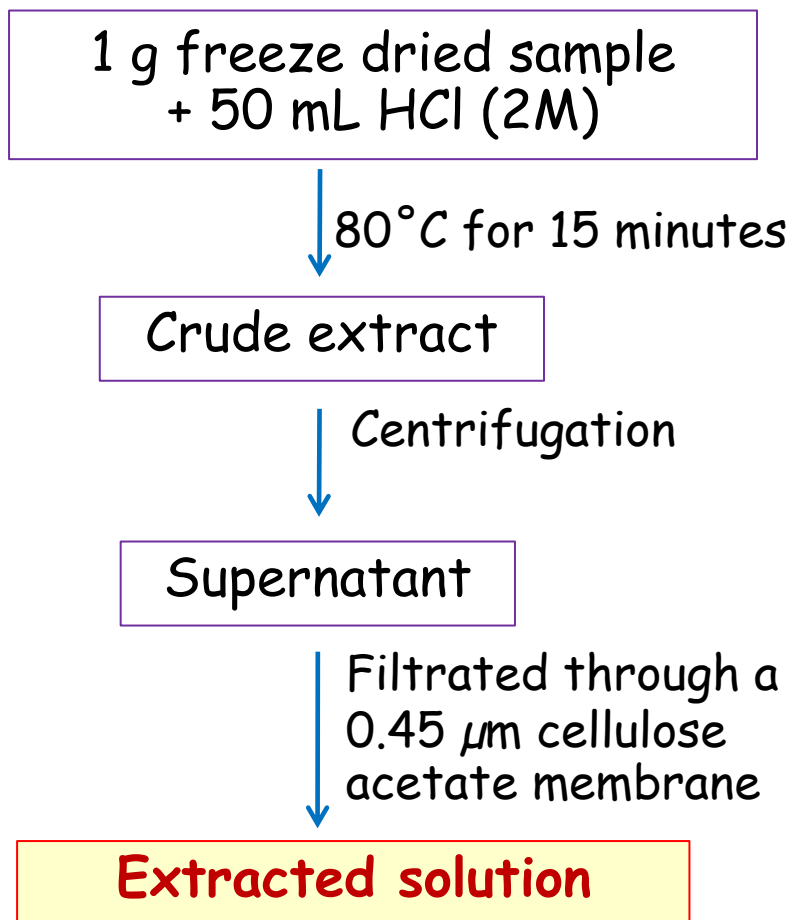
| No. | Thai name | Scientific name | Picture | Sour taste? |
|-----|-------------|-----------------------------------|---|-------------|
| 1. | Pak-wan-pa | <i>Melientha suavis</i> Pierre |  | No |
| 2. | Ta-keuk | <i>Albizia lebeck</i> (L.) Benth |  | No |
| 3. | Kra-pee-jan | <i>Millettia brandisiana</i> Kurz |  | Yes |
| 4. | Kra-don | <i>Careya sphaerica</i> Roxb. |  | Yes |

Example of fruit-consumed plants

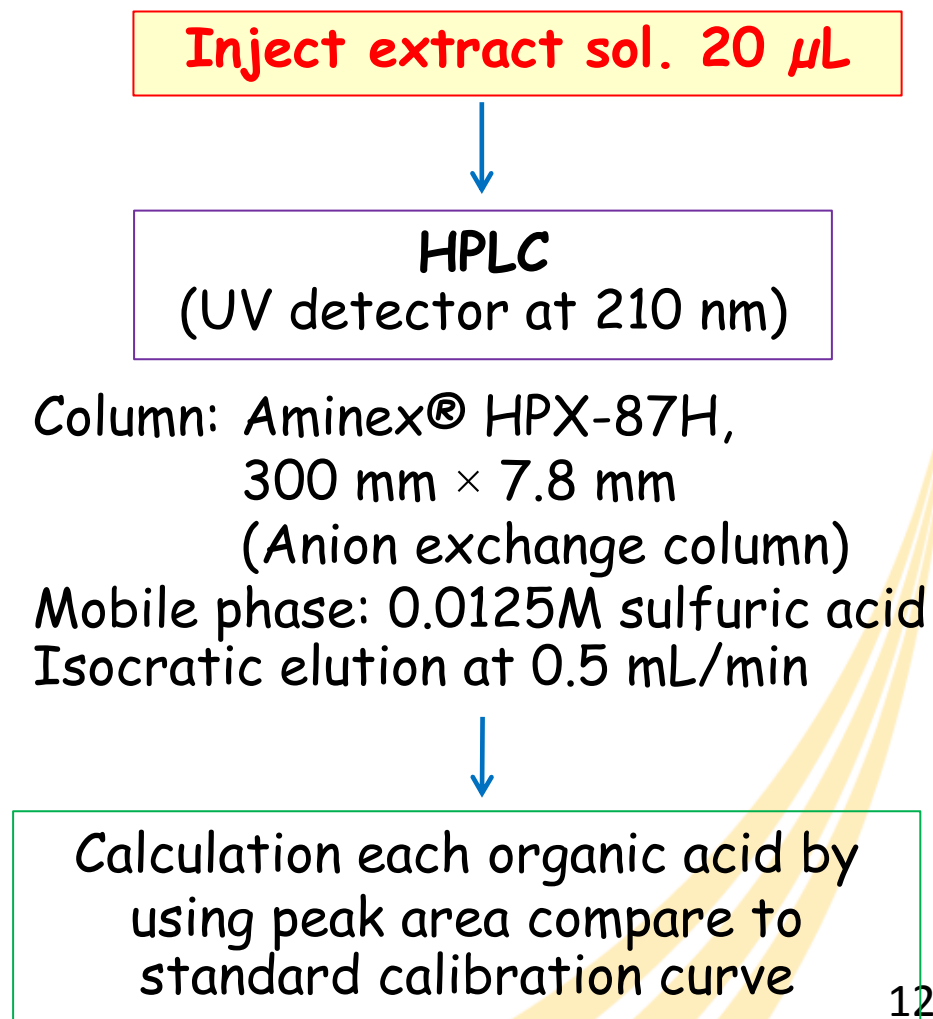
| No. | Thai name | Scientific name | Picture | Sour taste? |
|-----|-------------|--------------------------------------|--|-------------|
| 5. | Ma-karm-pom | <i>Phyllanthus emblica</i> L. |  | Yes |
| 6. | Ma-kok-pa | <i>Spondias pinnata</i> Kurz |  | Yes |
| 7. | Ma-mao | <i>Antidesma velutinsum</i> Blume |  | Yes |

Analysis of organic acids by HPLC method¹⁻²

1) Extraction organic acids:

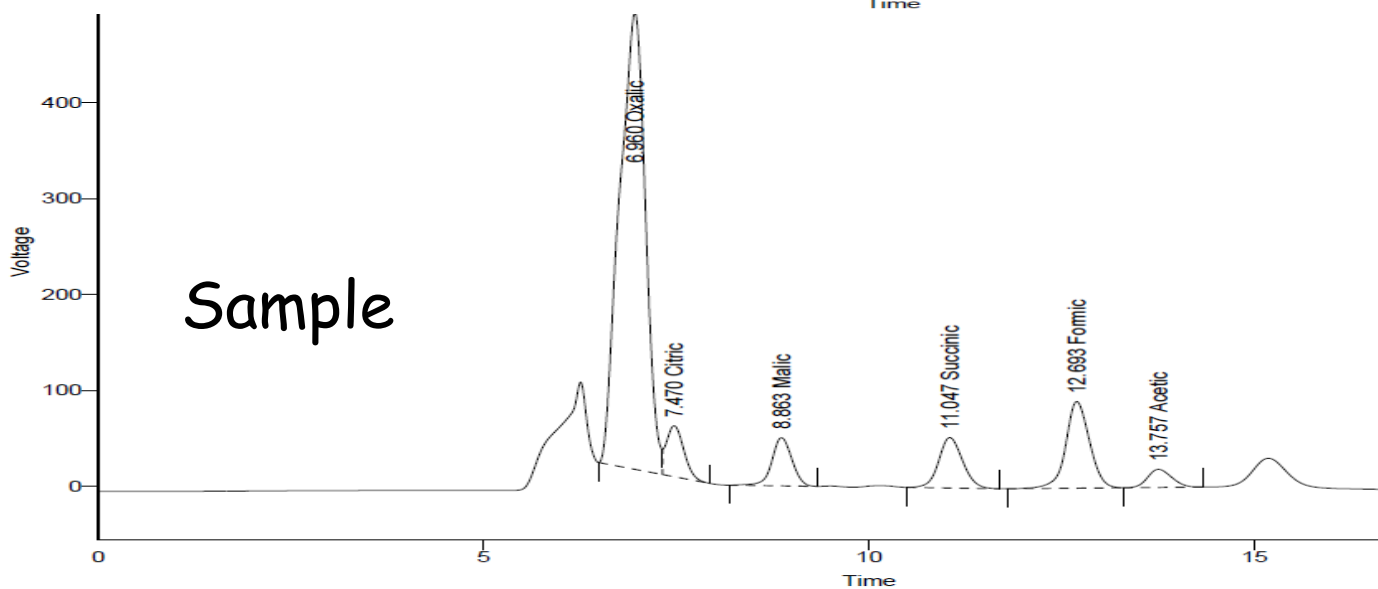
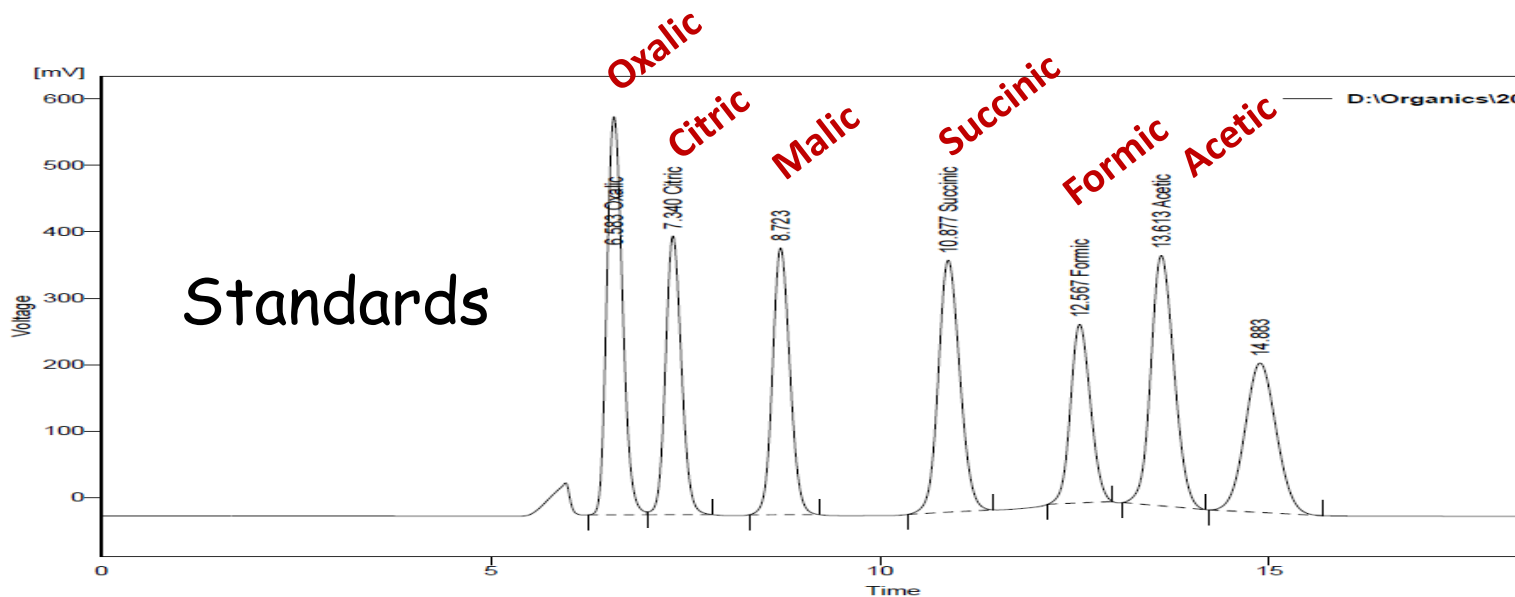


2) Organic acids determination:



¹Savage et al., JFCA, 2000

²Judprasong .et al., JFCA, 2006



Selectivity & Specificity ✓✓

Percent recovery study

| Organic acids | LOD | LOQ | % Recovery ± SD |
|---------------|------------|-----|--------------------|
| | (mg/100 g) | | |
| Oxalic acid | 0.9 | 3 | 90.6 ± 11.5 |
| Citric acid | 2.2 | 7.3 | 91.8 ± 9.7 |
| Malic acid | 2 | 12 | 97.8 ± 5.4 |
| Succinic acid | 0.2 | 0.5 | 98.1 ± 7.3 |
| Formic acid | 0.1 | 0.5 | 95.1 ± 2.3 |
| Acetic acid | 3 | 9 | 99.4 ± 3.5 |

Acceptable recovery is 90-108% at the conc. level of 0.1% (AOAC, Guidelines for Single Laboratory Validation of Chemical Methods for Dietary Supplements and Botanicals, 2002).



Accuracy ✓✓

In-house quality control sample



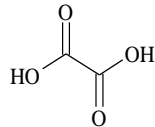
In-house QC sample:

Cha-moung (*Garcinia cowa* Roxb.) leaf

- It contained significant amounts of most organic acids
- It was analysed along with unknown samples in each run.
- Each organic acid content is stayed within the ± 2 SD, with the relative standard deviation of less than 9%



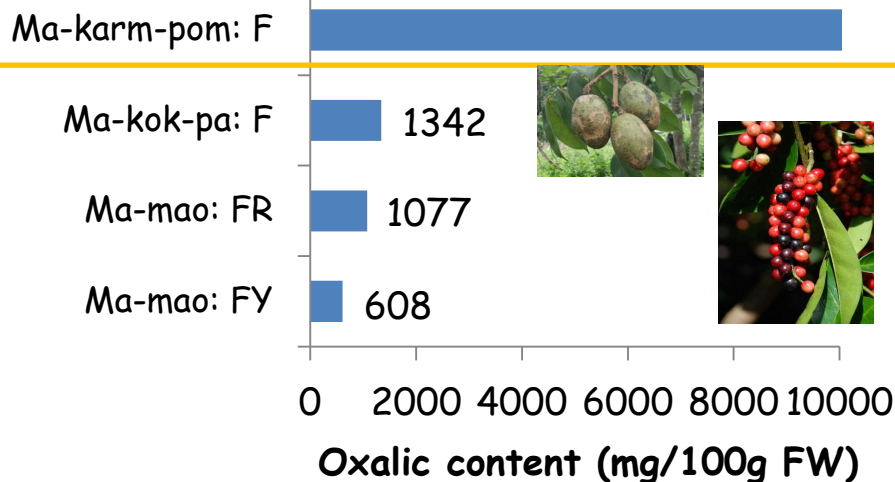
Precision ✓✓



Results: Oxalic acid



Fruits consumed plants



Vitamin C (mg/100g)

Sour taste

575 ± 152

✓✓✓

37 ± 10

✓✓✓

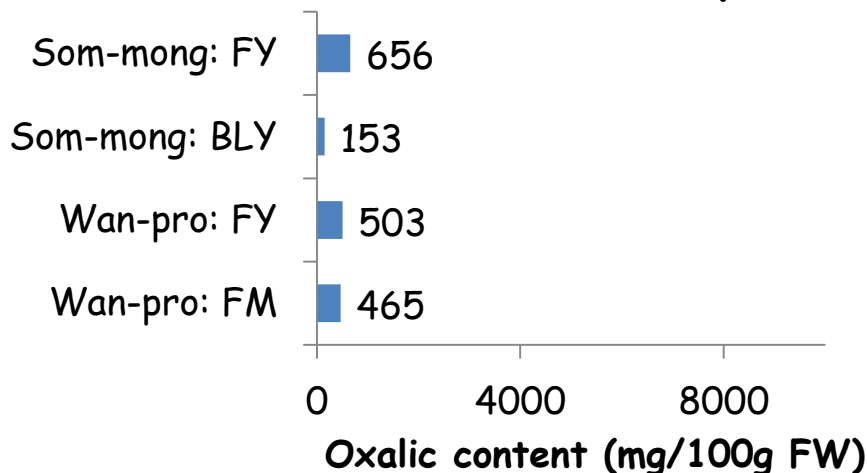
2 ± 1

✓✓✓

2 ± 1

✓✓✓

Leaves consumed plants



3 ± 1

✓✓✓

3 ± 1

✓✓✓

4 ± 1

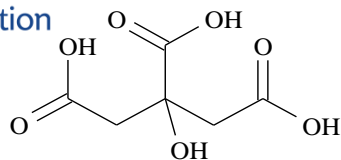
-

4 ± 1

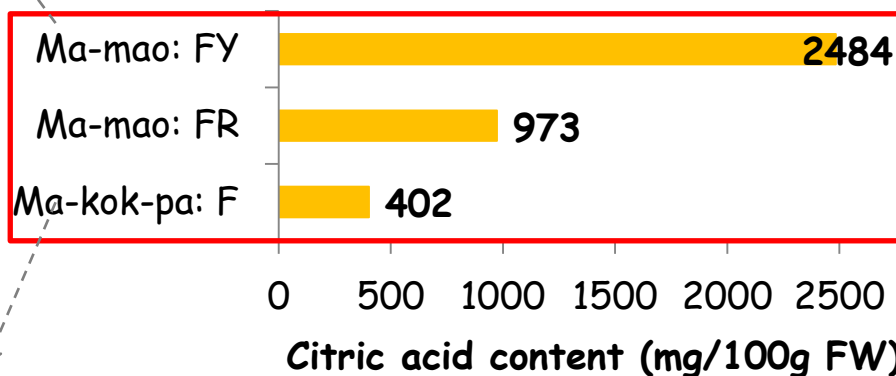
-

✓ = sour taste ranking
- = no sour taste

Results: Citric acid



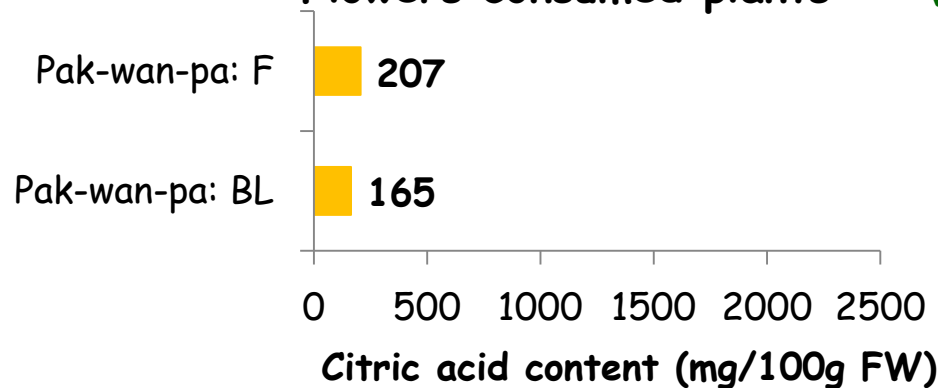
Fruits consumed plants



Vitamin C (mg/100g) Sour taste

| | |
|---------|-----|
| 2 ± 1 | ✓✓✓ |
| 2 ± 1 | ✓✓✓ |
| 37 ± 10 | ✓✓✓ |

Flowers consumed plants



Vitamin C (mg/100g) Sour taste

| | |
|----|---|
| 30 | - |
| 26 | - |

✓ = sour taste ranking
- = no sour taste

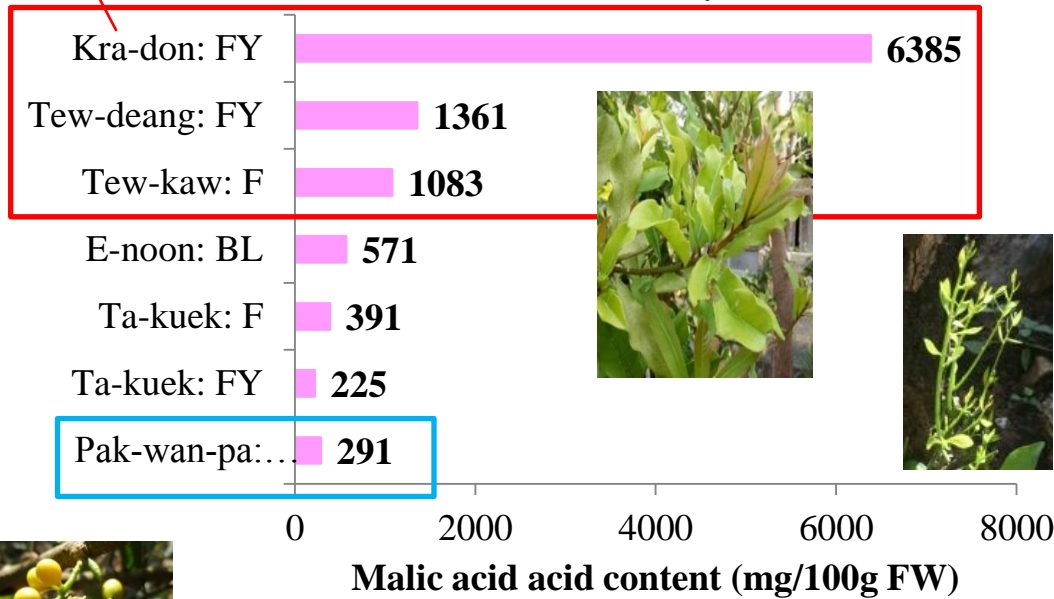
*FY = Fresh young, FR = Fresh ripped, BL = Blanched,



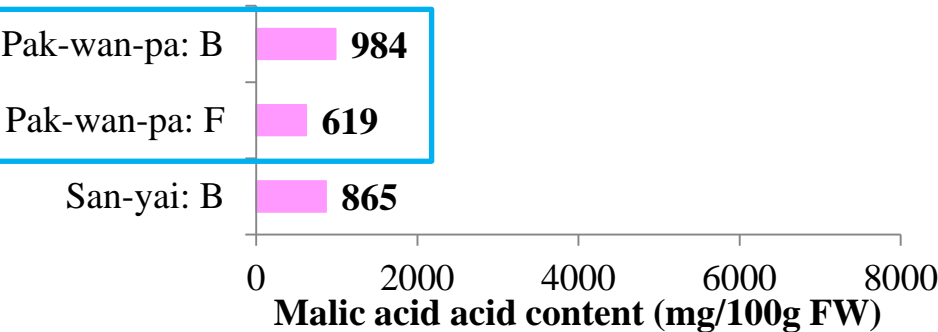
Nutrition
 ty

Results: Malic acid

Leaves consumed plants



Fruits consumed plants



Vitamin C (mg/100g) Sour taste

| | |
|-----|-----|
| 8 | ✓ |
| 3 | ✓✓✓ |
| 3 | ✓✓✓ |
| 23 | ✓ |
| 161 | - |
| 161 | - |
| 69 | - |

✓ = sour taste ranking
 - = no sour taste

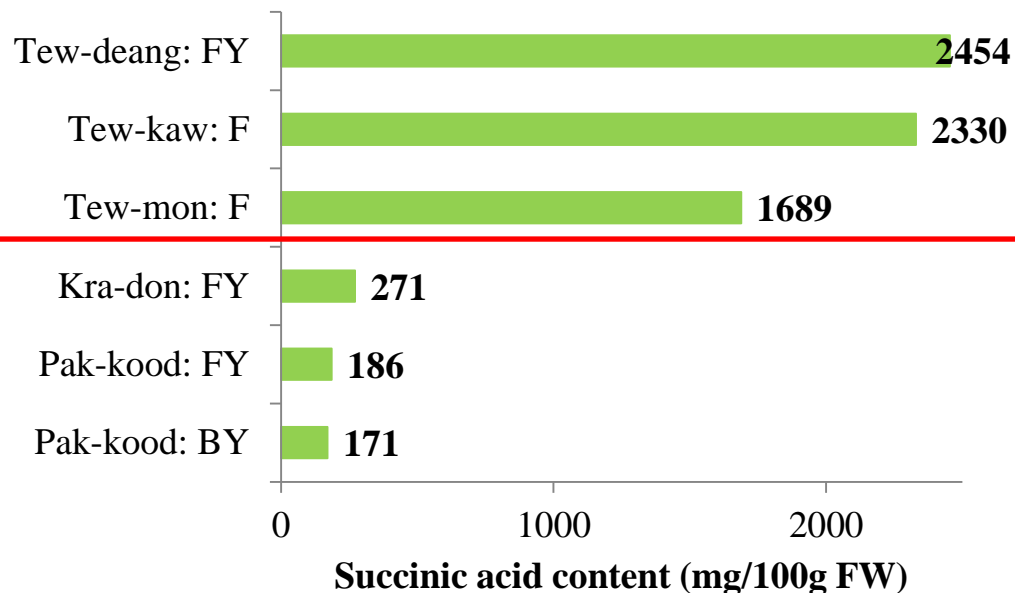
*FY = Fresh young, F = Fresh, BL = Blanched, B = Boiled



Family of *Guttiferae*



Leaves consumed plants



Vitamin C (mg/100g) Sour taste

3 ✓✓✓

3 ✓✓✓

3 ✓✓✓

8 ✓

5 -

3 -

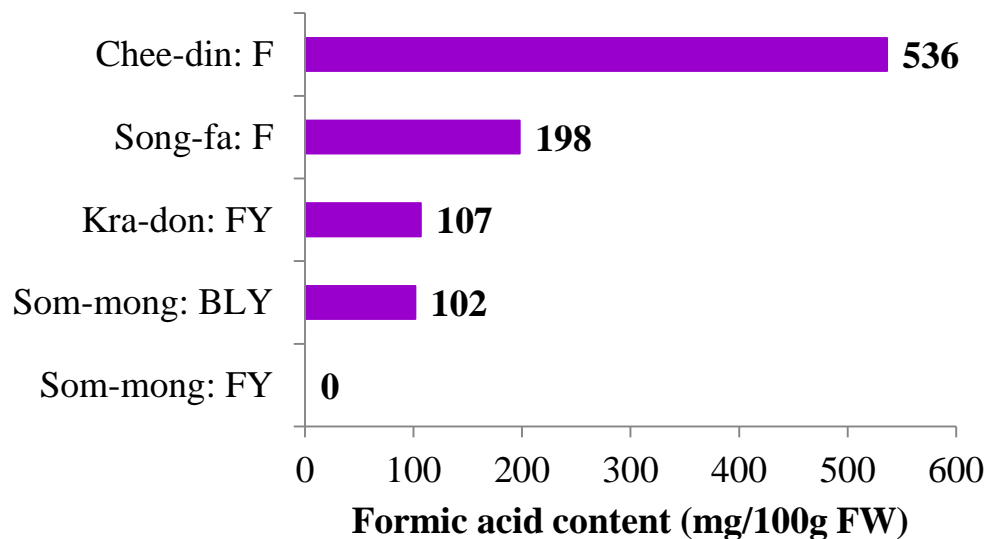
✓ = sour taste ranking
- = no sour taste

Health Benefit: Against ischemia/reperfusion cardiac injury
(Sakamoto M., et al., 1998)

*FY = Fresh young, F = Fresh, BY = Boiled young

Results: Formic acid

Leaves consumed plants



Vitamin C (mg/100g) Sour taste

Not detected ✓✓✓

Not detected ✓✓✓

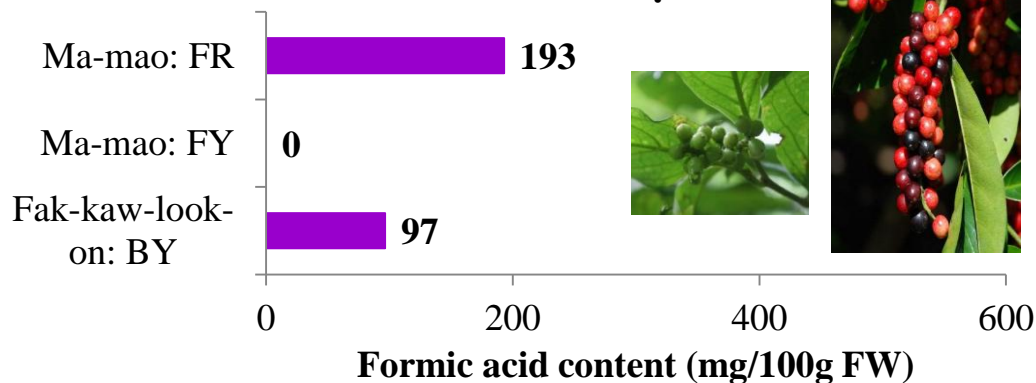
8 ✓

5 -

3 -

✓ = sour taste ranking
- = no sour taste

Fruits consumed plants



2 ✓✓✓

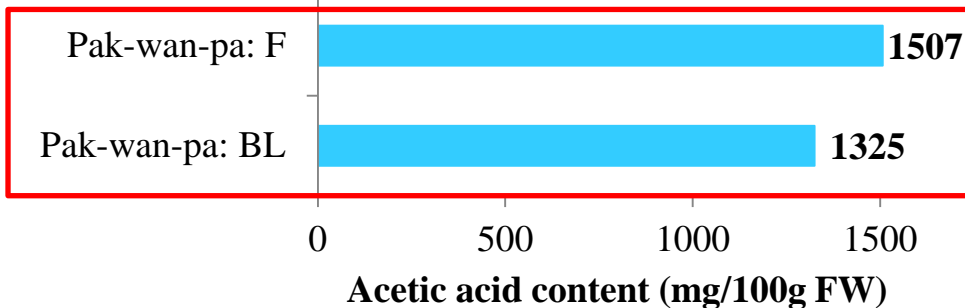
2 ✓✓✓

Not detected -

Results: Acetic acid



Flowers consumed plants



Vitamin C (mg/100g)

37

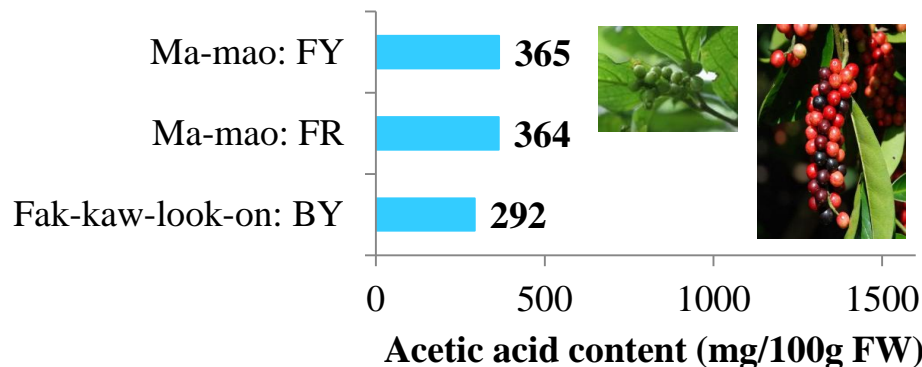
43

Sour taste

-

-

Fruits consumed plants



Vitamin C (mg/100g)

2

2

Not detected

Sour taste

✓✓✓

✓

-

Health Benefit: increase absorption of mineral
(Sakamoto M., et al., 1998)

Correlation between vitamin C and organic acid contents

| Parameters | Correlation coefficient (<i>r</i>) | | |
|----------------------|---|---|-----------------------|
| | Samples containing vitamin C <100 mg/100g (n=28) | Samples containing vitamin C >100 mg/100g (n=10) | All samples (n=38) |
| Sum of organic acids | -0.04 | 0.59 | 0.48 |
| Oxalic acid | -0.09 | 0.29 | 0.37 |
| Citric acid | -0.11 | -0.09 | -0.15 |
| <u>Malic acid</u> | -0.06 | 0.68 | -0.02 |
| <u>Succinic acid</u> | -0.25 | 0.76 | 0.75 |
| Formic acid | -0.03 | -0.41 | -0.02 |
| Acetic acid | 0.03 | -0.36 | -0.09 |

Selected indigenous plants

| Indigenous samples | Moist. (g/100g) | Organic acid (mg/100g FW) | | | | | | | Vit. C (mg/100 g) | Sour taste ranking | Energy increase (Kcal) |
|-------------------------------|--------------------|---------------------------|--------|-------|----------|--------|--------|-------|-------------------------|--------------------------|------------------------------|
| | | Oxalic | Citric | Malic | Succinic | Formic | Acetic | Sum | | | |
| Ma-karm-pom: fresh fruits | 80.3 | 11903 | 0 | 0 | 6 | 0 | 0 | 11909 | 575 | ✓✓✓ | 36 |
| Kra-don: fresh flowers | 84.1 | 98 | 0 | 7929 | 84 | 0 | | 8111 | 3 | ✓ | 24 |
| Ma-mao: fresh young fruits | 72.7 | 608 | 2484 | 0 | 0 | 0 | 365 | 3457 | 2 | ✓✓✓ | 10 |
| Ma-mao: fresh ripe fruits | 72.7 | 1077 | 973 | 86 | 0 | 193 | 364 | 2693 | 2 | ✓✓✓ | 8 |
| Tew-deang: fresh young leaves | 79.0 | 31 | 0 | 132 | 2454 | 0 | 0 | 2617 | 3 | ✓✓✓ | 8 |
| Tew-kaw: fresh leaves | 81.4 | 31 | 0 | 168 | 2330 | 0 | 20 | 2548 | 3 | ✓✓✓ | 8 |
| Tew-mon: fresh leaves | 80.0 | 68 | 26 | 391 | 1689 | 71 | 139 | 2383 | 3 | ✓✓✓ | 7 |
| Wan-pro: fresh young leaves | 94.2 | 502 | 0 | 1361 | 0 | 0 | 0 | 1863 | 4 | - | 6 |
| Ma-kok-pa: fresh fruits | 81.9 | 1342 | 402 | 0 | 0 | 0 | 0 | 1744 | 37 | ✓✓✓ | 5 |
| Wan-pro: fresh mature leaves | 90.0 | 452 | 0 | 1083 | 0 | 9 | 106 | 1650 | 4 | - | 5 |
| Ta-keuk: fresh young leaves | 81.9 | 79 | 0 | 112 | 8 | 0 | 0 | 199 | 112- 169 | - | 1 |



Conclusion

1. Data of each organic acid in 55 Thai indigenous plant samples is firstly reported and compiled in the Thai FCDB.
2. There are no correlation between vitamin C and each organic acid except succinic acid at high amount of vitamin C.
3. Sour taste of plants cannot indicate that plants contain high vitamin C.
4. Energy obtained from organic acid may contribute total energy especially the one that has high organic acids.



Thank you very much for your attention.

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