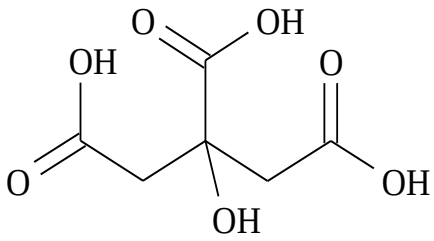
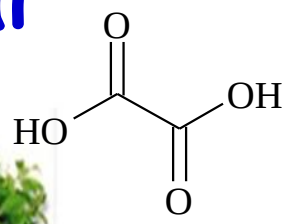
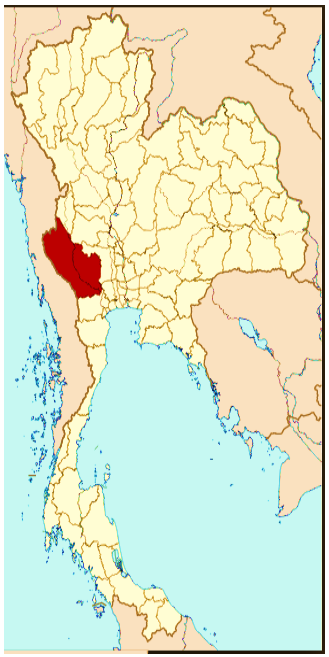
Organic acids make more sour taste than ascorbic acid in Thai indigenous plants







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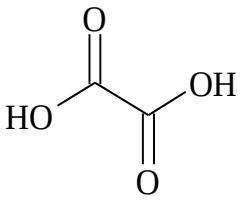
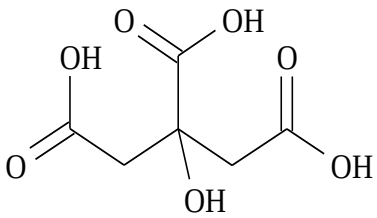
Organic acids

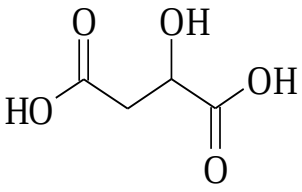
- Organic compounds have at least one carboxylic functional group (R-COOH).
- Organic acids are primary metabolites component that contributed to plant growth.
- They are found in great amount in all plants especially in vegetables and fruits and other manufacture products such as vinegar, salad dressings.



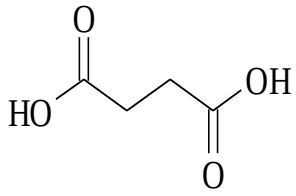
Oxalic



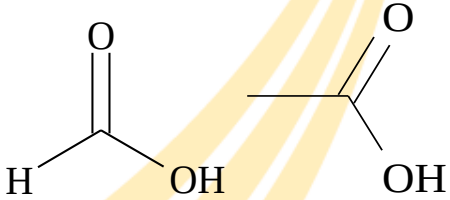
Citric



Malic



Succinic



Formic

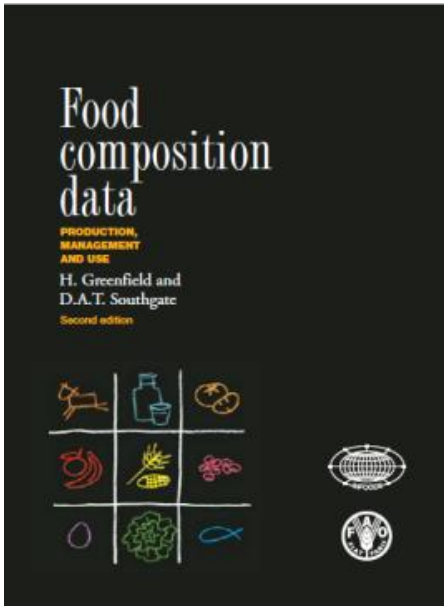
Acetic 2

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 **x 4** +
    Fat **x 9** +
    Protein **x 4** +
    Alcohol **x 7** +
    Organic acid x 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).

Ma-mao (Thai name)
(*Antidesma ghaesembilla* Gaertn.):
Commonly eaten as fresh or fruit juice

Vitamin C 1-3 mg/100g

Organic acid ?

- 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	*Meliantha suavis Pierre*		No
2.	Ta-keuk	*Albizia lebbeck* (L.) Benth		No
3.	Kra-pee-jan	*Millettia brandisiana* Kurz		Yes
4.	Kra-don	*Careya sphaerica Roxb.*		Yes

Example of fruit-consumed plants

No.	Thai name	Scientific name	Picture	Sour taste?
5.	Ma-karm-pom	*Phyllanthus emblica* L.		Yes
6.	Ma-kok-pa	*Spondias pinnata* Kurz		Yes
7.	Ma-mao	*Antidesma velutinosum Blume*		Yes

Analysis of organic acids by HPLC method[1-2]

1) Extraction organic acids:

1 g freeze dried sample
+ 50 mL HCl (2M)

↓ 80°C for 15 minutes

Crude extract

↓ Centrifugation

Supernatant

↓ Filtrated through a 0.45 µm cellulose acetate membrane

Extracted solution

2) Organic acids determination:

Inject extract sol. 20 µL

↓

HPLC
(UV detector at 210 nm)

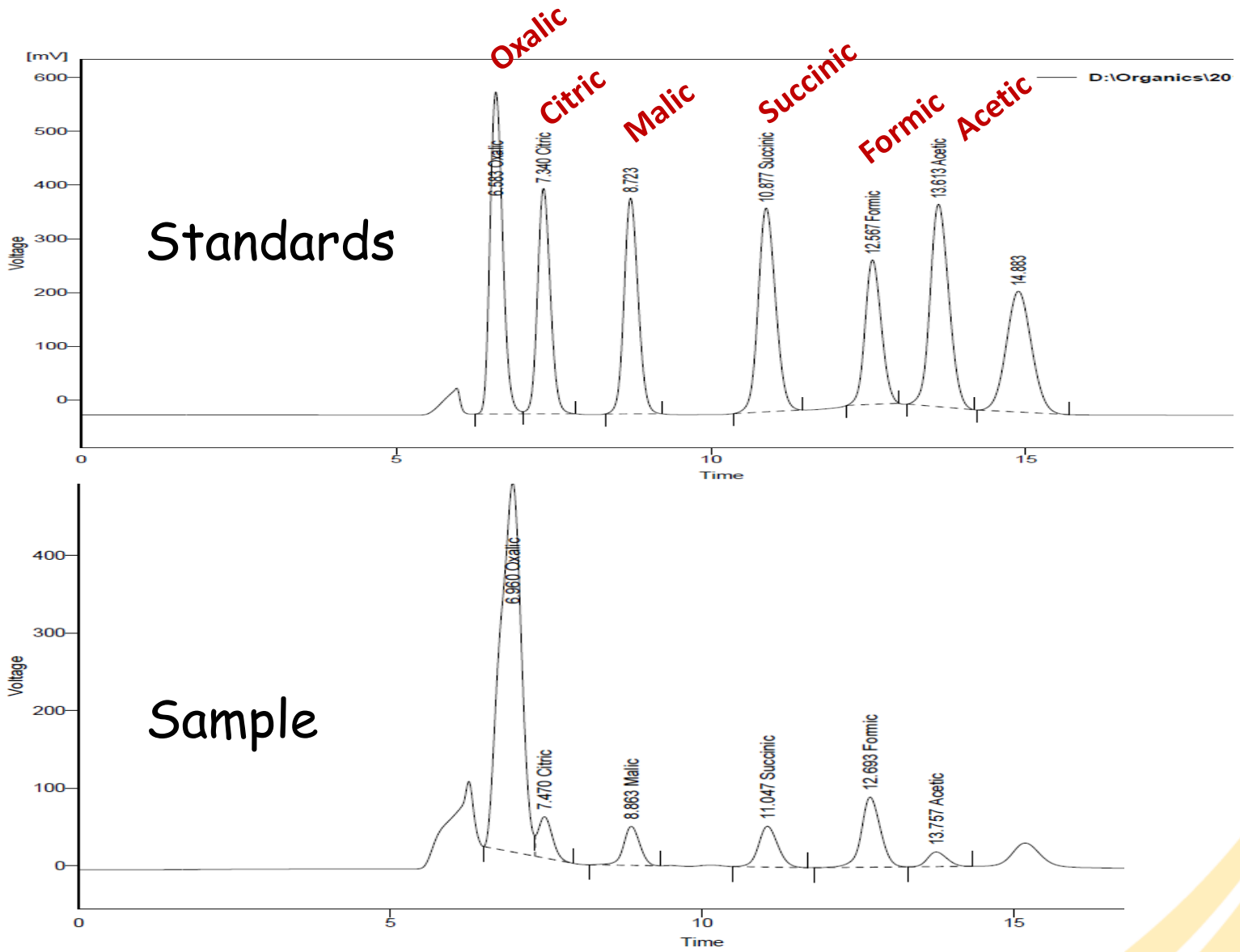
Column: Aminex® HPX-87H,
300 mm × 7.8 mm
(Anion exchange column)
Mobile phase: 0.0125M sulfuric acid
Isocratic elution at 0.5 mL/min

↓

Calculation each organic acid by using peak area compare to standard calibration curve

[1]Savage et al., JFCA, 2000
[2]Judprasong .et al., JFCA, 2006

Chromatogram of organic acid



Selectivity & Specificity ✓✓

Results & Discussion

Percent recovery study

Organic acids	LOD (mg/100 g)	LOQ (mg/100 g)	% Recovery ± SD
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 ✓✓

LOD = Limit of detection (3 S_0') and LOQ = limit of quantitation (10 S_0')

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 ✓✓

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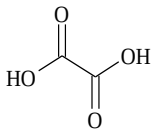
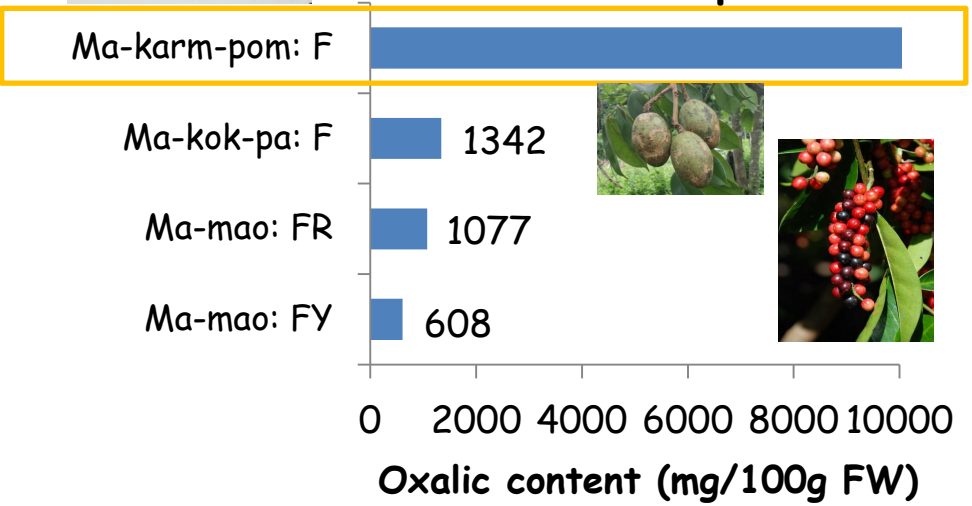


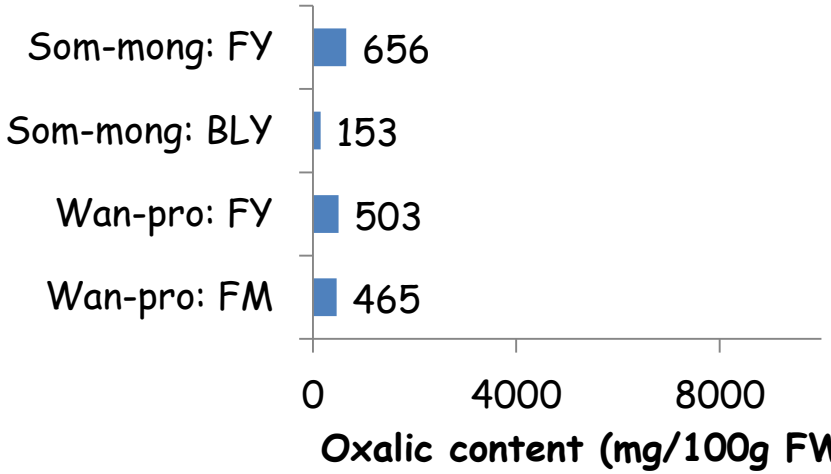
Results: Oxalic acid

12th INTERNATIONAL FOOD DATA CONFERENCE October, 11th-13th 2017 Cultural Center Of Science (CCI) - Buenos Aires-Argentina

Fruits consumed plants



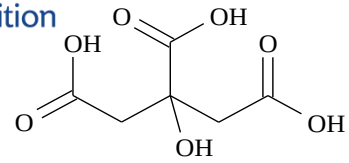
Leaves consumed plants



	Vitamin C (mg/100g)	Sour taste
Ma-karm-pom: F	575 ± 152	✓✓✓
Ma-kok-pa: F	37 ± 10	✓✓✓
Ma-mao: FR	2 ± 1	✓✓✓
Ma-mao: FY	2 ± 1	✓✓✓
Som-mong: FY	3 ± 1	✓✓✓
Som-mong: BLY	3 ± 1	✓✓✓
Wan-pro: FY	4 ± 1	-
Wan-pro: FM	4 ± 1	-

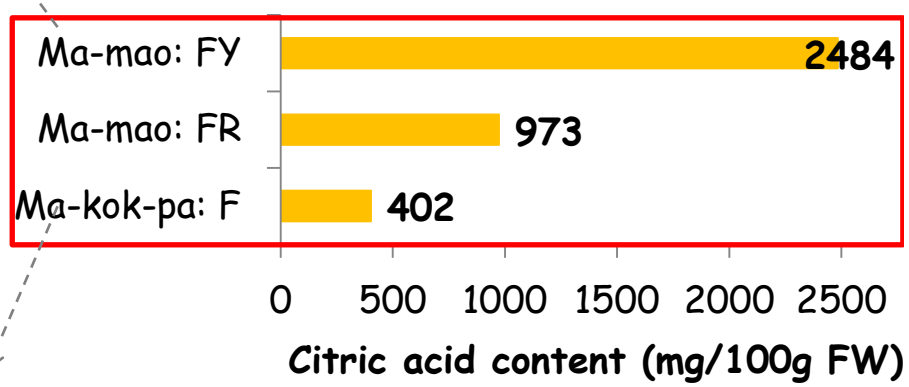
✓ = sour taste ranking
- = no sour taste

*F = Fresh, FR = Fresh ripped, FY = Fresh young, BLY = Blanched young , FM = Fresh mature,



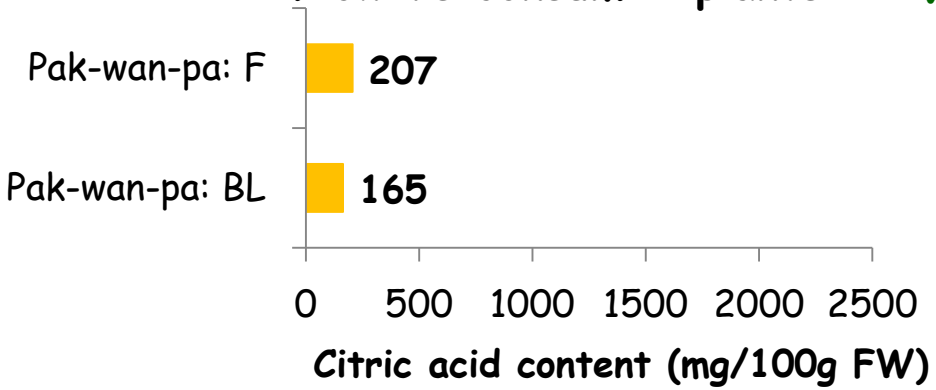
Results: Citric acid

Fruits consumed plants



	Vitamin C (mg/100g)	Sour taste
Ma-mao: FY	2 ± 1	✓✓✓
Ma-mao: FR	2 ± 1	✓✓✓
Ma-kok-pa: F	37 ± 10	✓✓✓

Flowers consumed plants



	Vitamin C (mg/100g)	Sour taste
Pak-wan-pa: F	30	-
Pak-wan-pa: BL	26	-

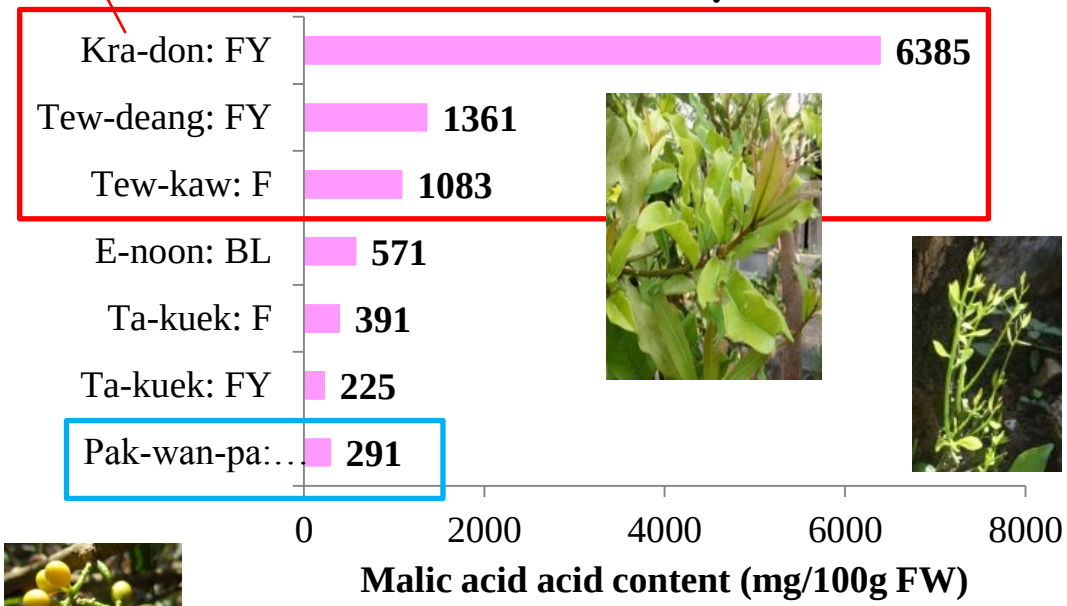
✓ = sour taste ranking
- = no sour taste

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

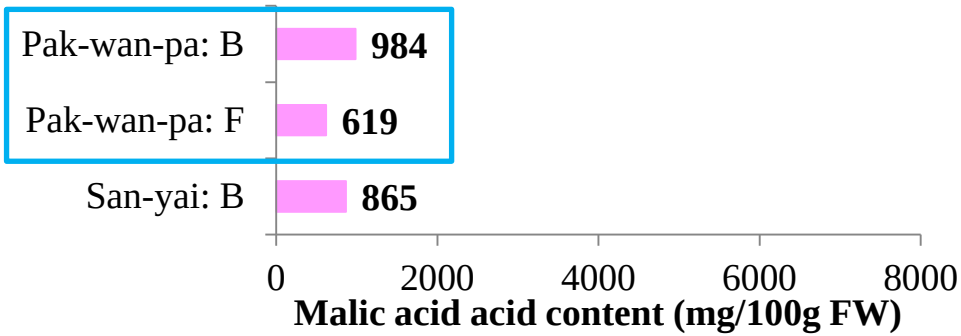
Nutrition

Results: Malic acid

Leaves consumed plants



Fruits consumed plants



	Vitamin C (mg/100g)	Sour taste
Kra-don: FY	8	✓
Tew-deang: FY	3	✓✓✓
Tew-kaw: F	3	✓✓✓
E-noon: BL	23	✓
Ta-kuek: F	161	-
Ta-kuek: FY	161	-
Pak-wan-pa:…	69	-
Pak-wan-pa: B	30	-
Pak-wan-pa: F	26	-
San-yai: B	1	-

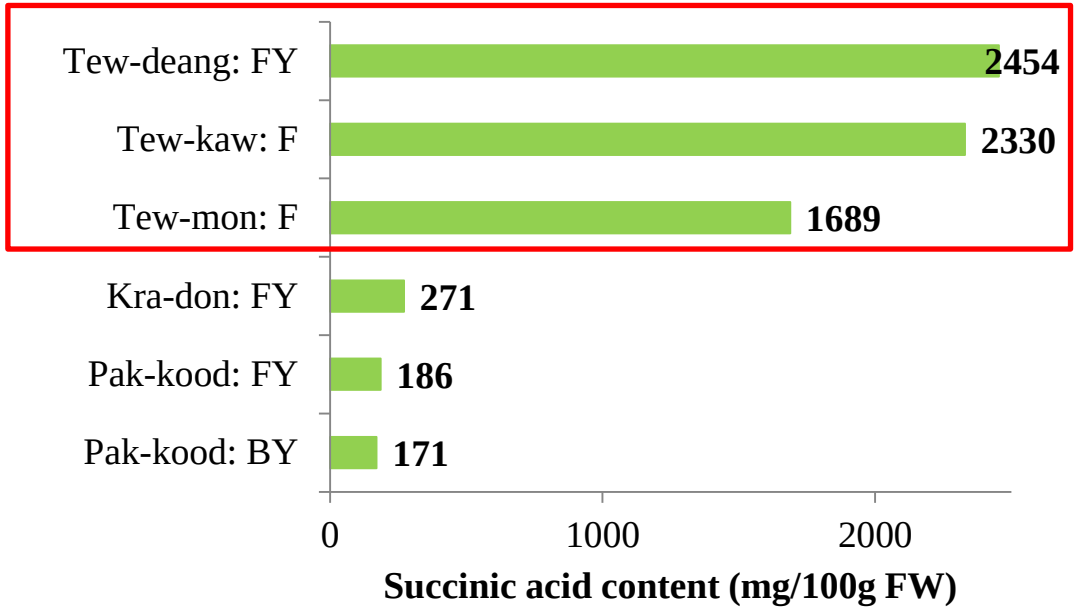
✓ = sour taste ranking
- = no sour taste

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

Results: Succinic acid

Family of *Guttiferae*

Leaves consumed plants



Vitamin C (mg/100g)	Sour taste
3	✓✓✓
3	✓✓✓
3	✓✓✓
8	✓
5	-
3	-

✓ = sour taste ranking
- = no sour taste

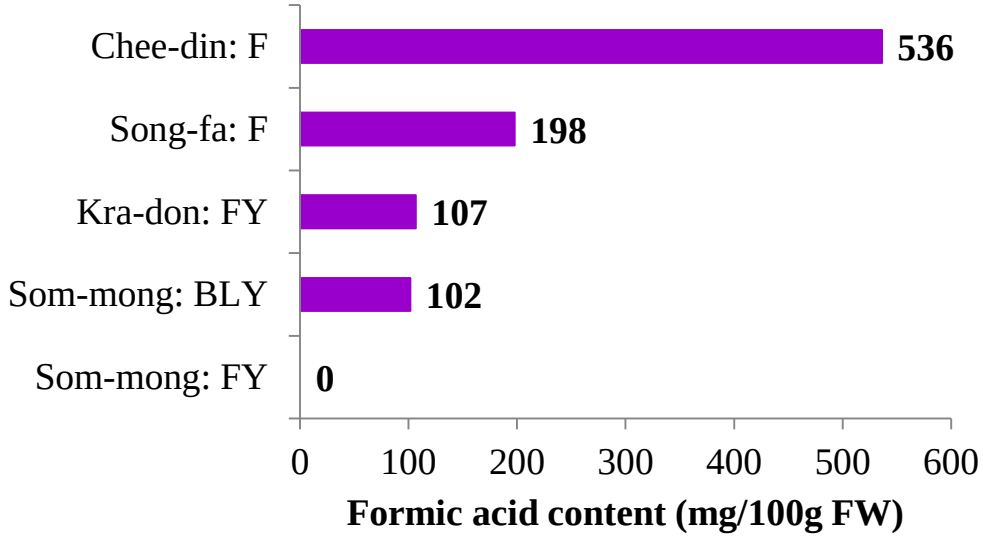
Health Benefit: Against ischemia/reperfusion cardiac injury

(Sakamoto M., et al., 1998)

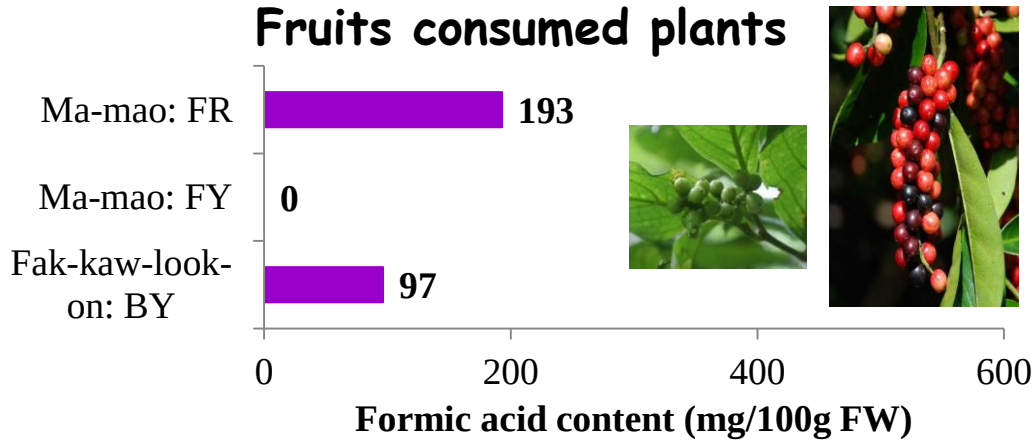
*FY = Fresh young, F = Fresh, BY = Boiled young

Results: Formic acid

Leaves consumed plants



Fruits consumed plants



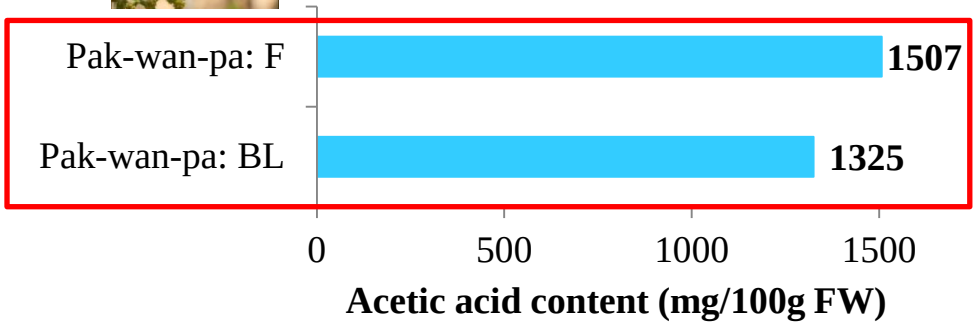
Vitamin C (mg/100g)	Sour taste
Not detected	✓✓✓
Not detected	✓✓✓
8	✓
5	-
3	-
2	✓✓✓
2	✓✓✓
Not detected	-

✓ = sour taste ranking
- = no sour taste

*F = Fresh, FY = Fresh young, BLY = Blanched young , FR = Fresh ripped, BY = Boiled young

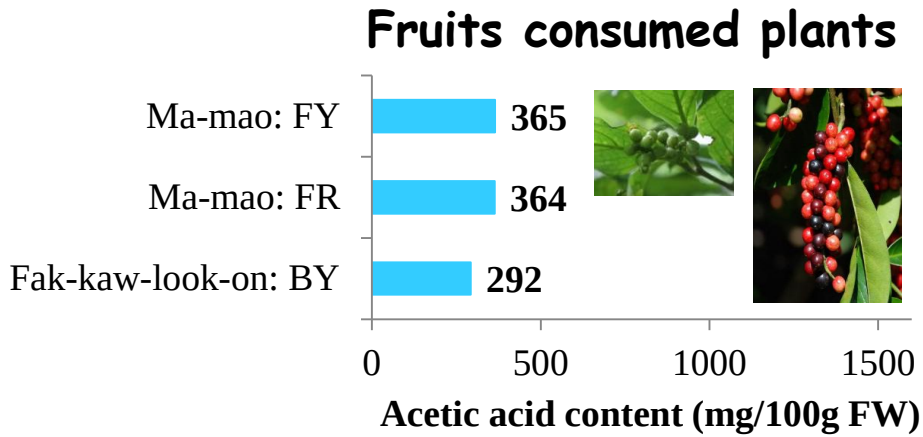
Results: Acetic acid

Flowers consumed plants



	Vitamin C (mg/100g)	Sour taste
Pak-wan-pa: F	37	-
Pak-wan-pa: BL	43	-

Fruits consumed plants



	Vitamin C (mg/100g)	Sour taste
Ma-mao: FY	2	✓✓✓
Ma-mao: FR	2	✓
Fak-kaw-look-on: BY	Not detected	-

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

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

Correlation between vitamin C and organic acid contents

Parameters	Correlation coefficient (*r*)		
	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
Malic acid	-0.06	0.68	-0.02
Succinic acid	-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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