Developing the Market Potential of Mangosteen as A Superfruit:

Focus on Quality Enhancements, Promotional Requirements and Market Expansion

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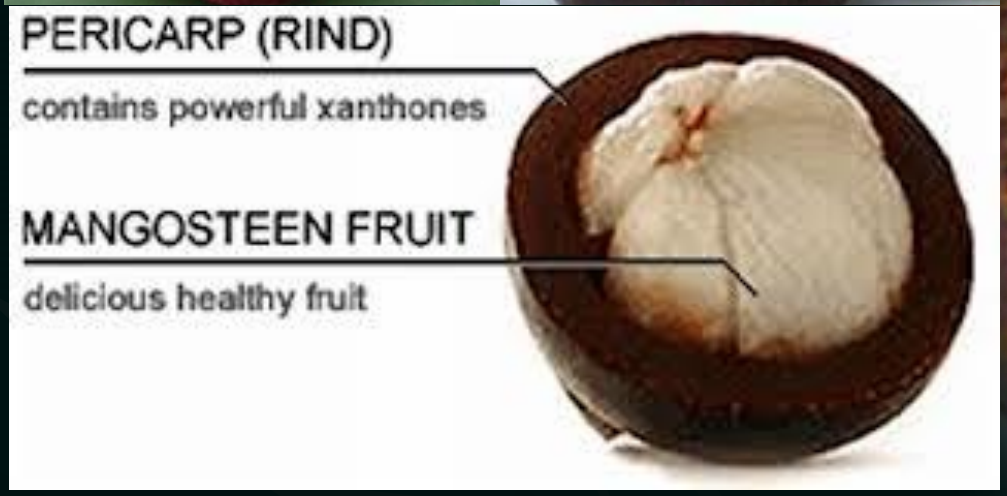
Mangosteen (*Garcinia mangostana*)

- Mangosteen is a tropical fruit native to Indonesia and other Southeast Asian countries which has been hailed as the “queen of tropical fruits” due to its beautiful appearance and delicious taste
- The mangosteen recently became very popular because of the content of xanthones in the pericarp

Mangosteen (*Garcinia mangostana*)

- The genus Garcinia belongs to the family *Clusiaceae* (syn. *Guttiferae*) which contains about 35 genera and up to 800 species.
- Mangosteen is maybe interspesific hybrid between
  - *G. malaccensis* and *G. celebica*



Mangosteen Fruit

Mangosteen Fruit Properties

No	Properties	Contens
1	Edible Portion	29 %
2	Energy	63 kcal
3	Protein	0,6 g
4	Fat	0,6 g
5	Carbohydrate	15,6 g
6	Ca	8 mg
7	P	12 mg
8	Fe	1 mg
9	Vitamin B1	0,03 mg
10	Vitamin C	2 mg

Xanthone is Phytonutrient

- Plant-derived compounds (phyto-)
- that promote health (nutrition)

- **Secondary metabolites:**
  - **Plants synthesize compounds that do not appear to be directly related to their growth and development.**
- **Many of these compounds hold promise for human health → phytonutrients.**

Xanthones

- Biologically active plant phenols
- Have a 6 carbon ring structure with double frame carbon.
- $C_{13}H_8O_2$
- All xanthones have the same frame structure, specificity is marked on the side chain of 1 to 8 carbon
- This structure makes xanthones very stable and versatile.

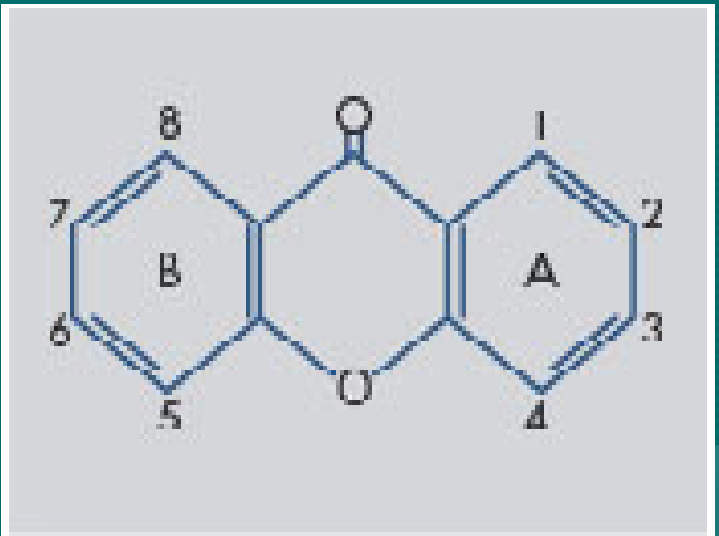
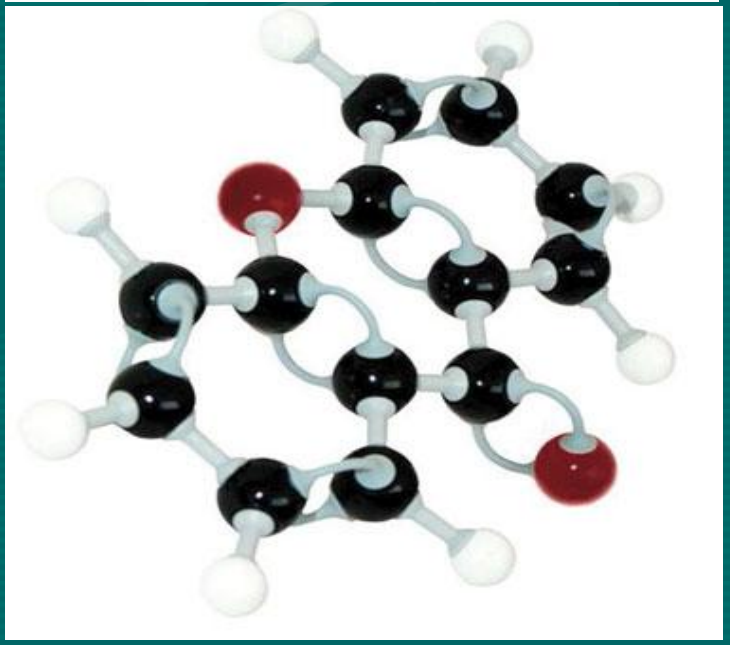


Figure A. Xanthone backbone



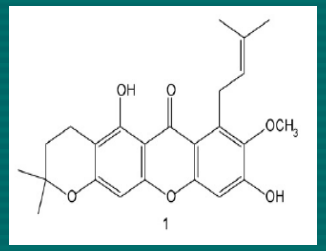
Xanthones profile in Indonesian mangosteen hull extract

(Kurniawati, Poerwanto, Sobir, Effendi, and Cahyana)

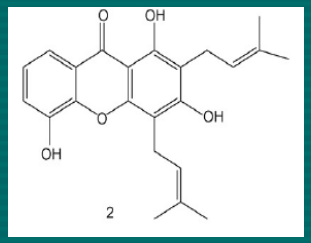
- 6 compounds were identified based on the UV spectrum and m/z:
  - α- mangostin,
  - β-mangostin
  - isomangostin,
  - gartanin,
  - 8-deoxygartanin and
  - 9-hydroxycalabanxanthone,
- 6 compounds were identified based on the m/z:
  - mangostanol
  - mangoxanthone
  - mangostinone
  - mangostenone A
  - mangostenone B
  - 6-O-methylmangostanine

Xanthones Structures from Indonesian Mangosteen

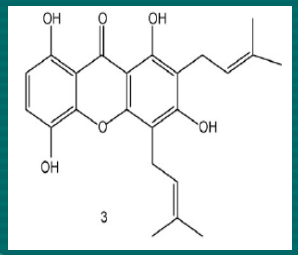
(Kurniawati)



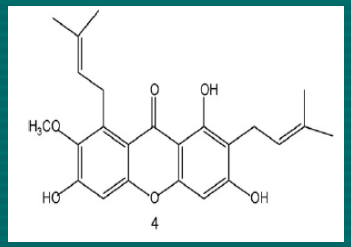
(1) 3-isomangostin



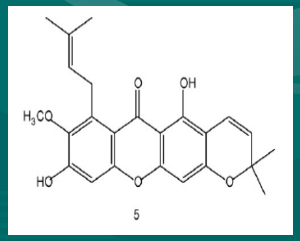
(2) 8-desoxygartanin



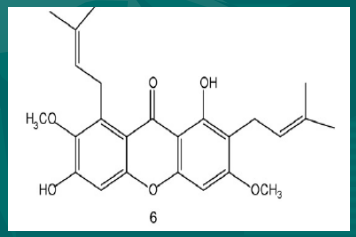
(3) gartanin



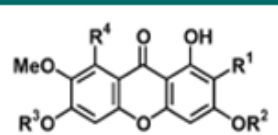
(4) α-mangostin



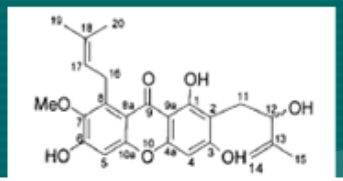
(5) 9-hydroxycalabaxanthone



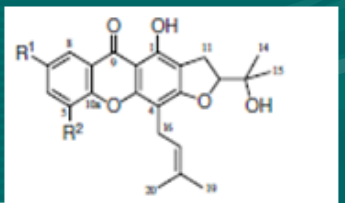
(6) β-mangostin



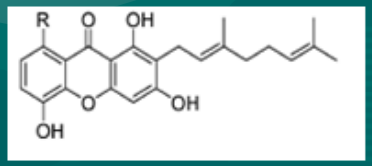
(1) Peak 2=(Dehydration 6-O-
R^2=R^3=Me, R4=C)



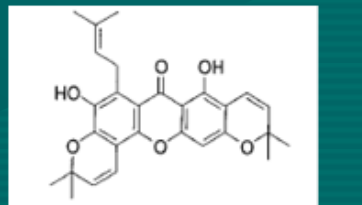
(2) Peak 7,8,9 =Mangostanol
methylmangostanine; R^1=A,



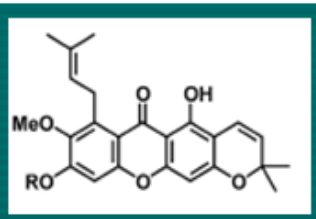
(3) Peak11=Mangoxanthone
(R^1=OH, R^2=H)



(4) Peak 13=Mangostinone
(R=H)



(5) Peak 19=Mangostenone A



(6) Peak 20= Garciniafuran 380.127

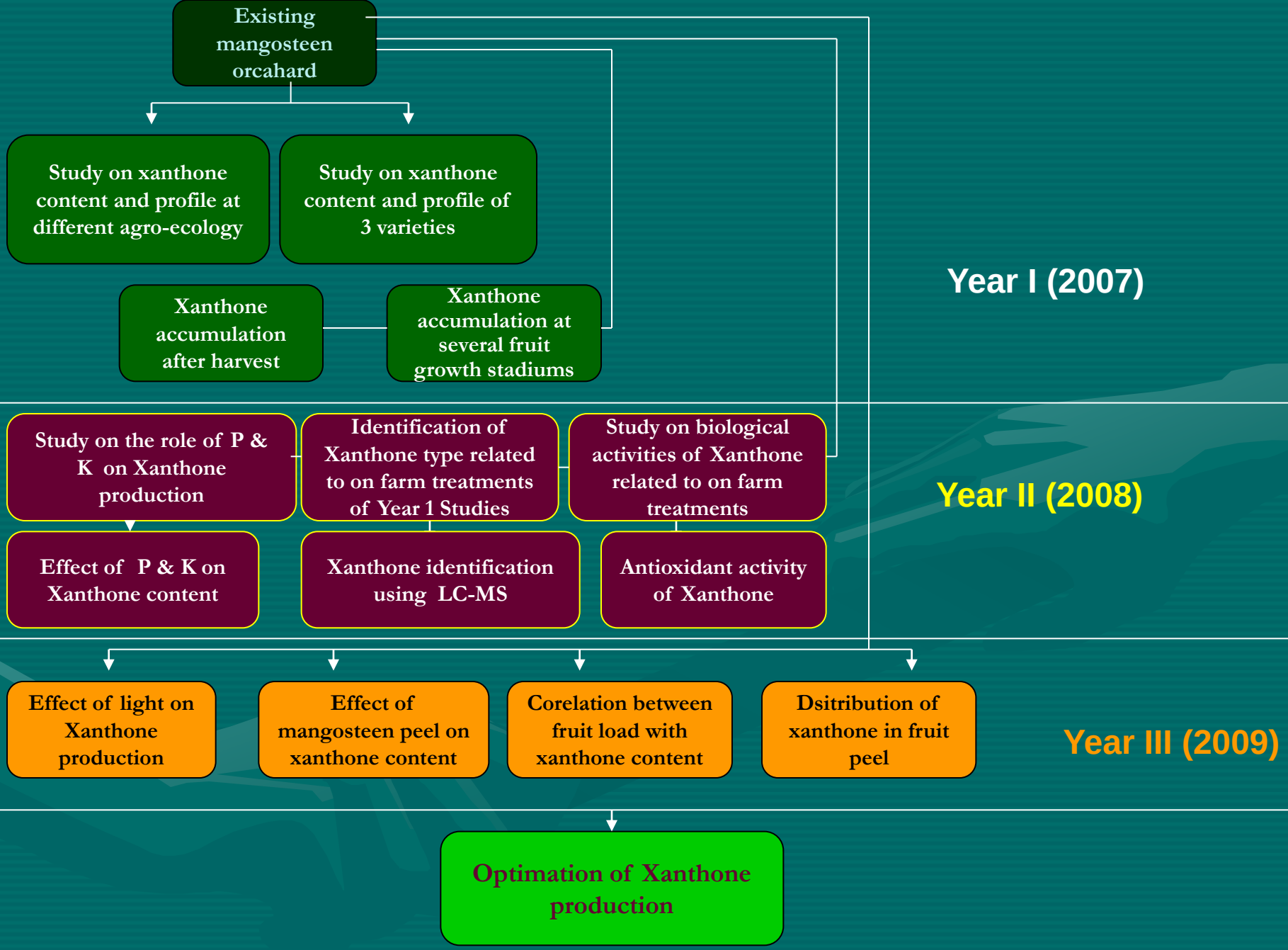
Factors Affecting Phytonutrient in Fruits and Their Activity

- Genotypes
- Growth Stage & Maturity
- Pre-harvest Conditions
  - Agro-ecology
  - Cultural Practices
    - Fertilizer,
    - Compost,
    - Bed Structure,
    - Ground Cover,
    - Soil,
    - Elevated carbon dioxide,
    - Pre-harvest application of natural compounds

- Postharvest Handling
  - Storage,
  - Modified atmosphere packaging,
  - Carbon dioxide,
  - Low oxygen treatment,
  - Heat treatment,
  - Irradiation,
  - Treatment natural compounds,
  - Fresh-cut

Our Research

- Study on the effects of genotype, agro-ecology & cultural practices on **xanthone** production in **mangosteen**:
  - 3 varieties: Wanayasa, Kaligesing, Watulimo
  - 4 location: Bogor, Purwakarta, Tasik Malaya, Trenggalek
  - Fruit growth stadium: 4, 8, 12, 16 weeks after anthesis
  - Fertilizer: N, P, K
  - Storage: at harvest, 2, & 4 weeks after harvest



Research in Xanthone

Research Result

1. Agro-ecology of the production center significantly affect xanthone production.
2. Xanthone accumulation in the fruit peel started at 1 month after anthesis (1.97 g/100 g crude extract), and it was higest at 4 month after anthesis (4.78 g/100 g CE)
3. Xanthone content at 0, 2, and 4 weeks after harvest was not significantly different
4. P fertilizer (0-600 kg/tree) decreasing xanthone content in the peel.
5. Nitrogen (0-1200 g/tree) and Potasium (0-1600 kg/tree) fertilizer was not affect xanthone content in the peel.

Xanthone Bioactive content in 5 Mangosteen Production Center in Java Island

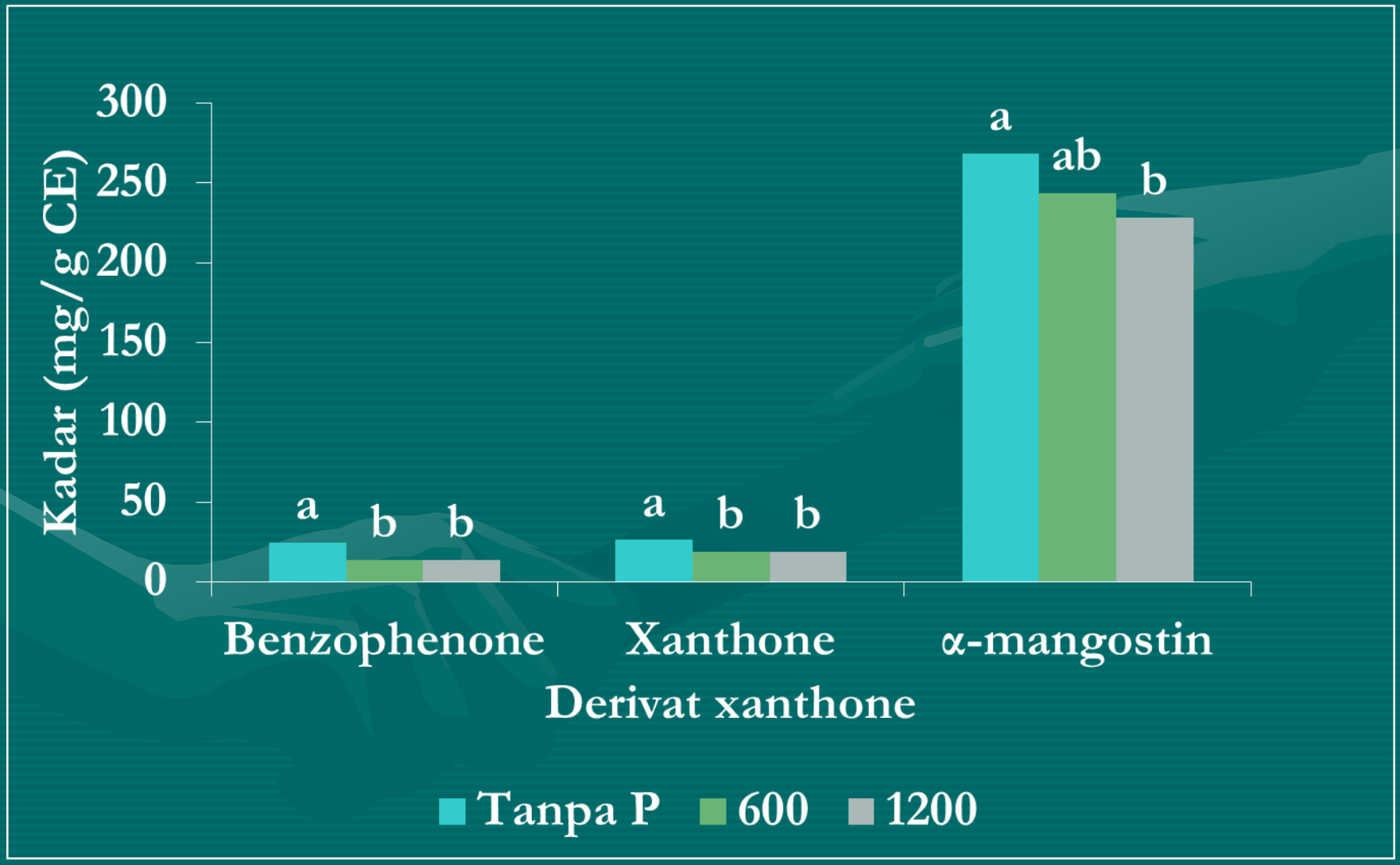
Production Center	Benzophenon		Xanthone Derivate			
			Xanthone standart		α-mangostin	
			(mg/g CE)			
Wanayasa	8.42	b	10.76	c	196.86	ab
Watulimo	20.60	a	22.67	a	201.30	ab
Kaligesing	7.13	b	11.31	bc	169.37	b
Puspahiang	10.40	b	17.46	ab	229.22	a
Leuwiliang	9.46	b	15.40	bc	216.68	ab
F test	**		*		*	

Xanthones Derivates in Mangosteen Fruit

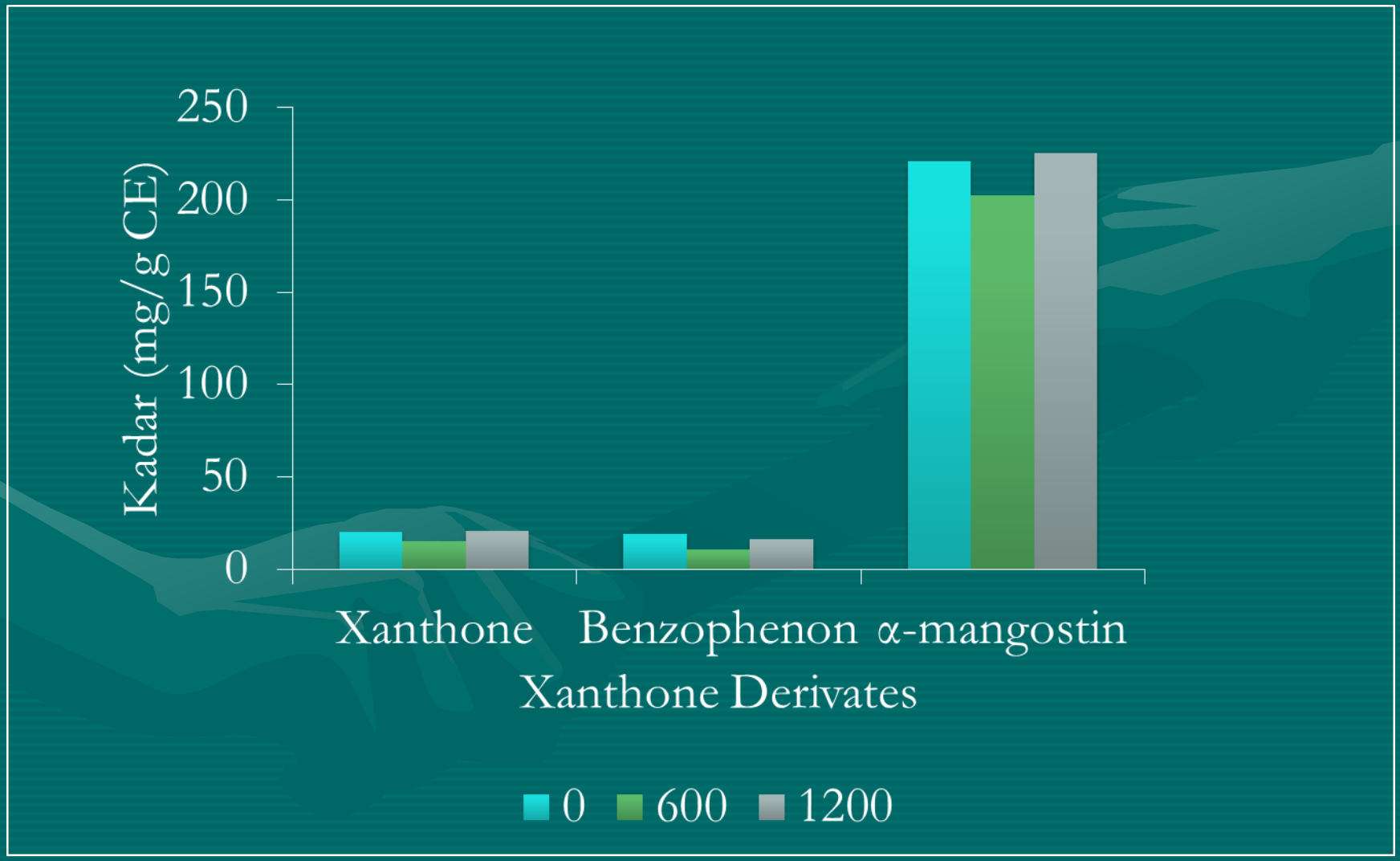
(Kurniawati, Poerwanto, Sobir, Effendi, and Cahyana)

Fruits Age	Benzophenon	Xanthones Derivates	
Month After Anthesis		Xanthone Standart	α-mangostin
	(mg/g CE)		
1	8.48	14.67	186.54
2	7.94	16.21	201.29
3	8.31	15.74	205.49
4	10.80	15.68	188.55

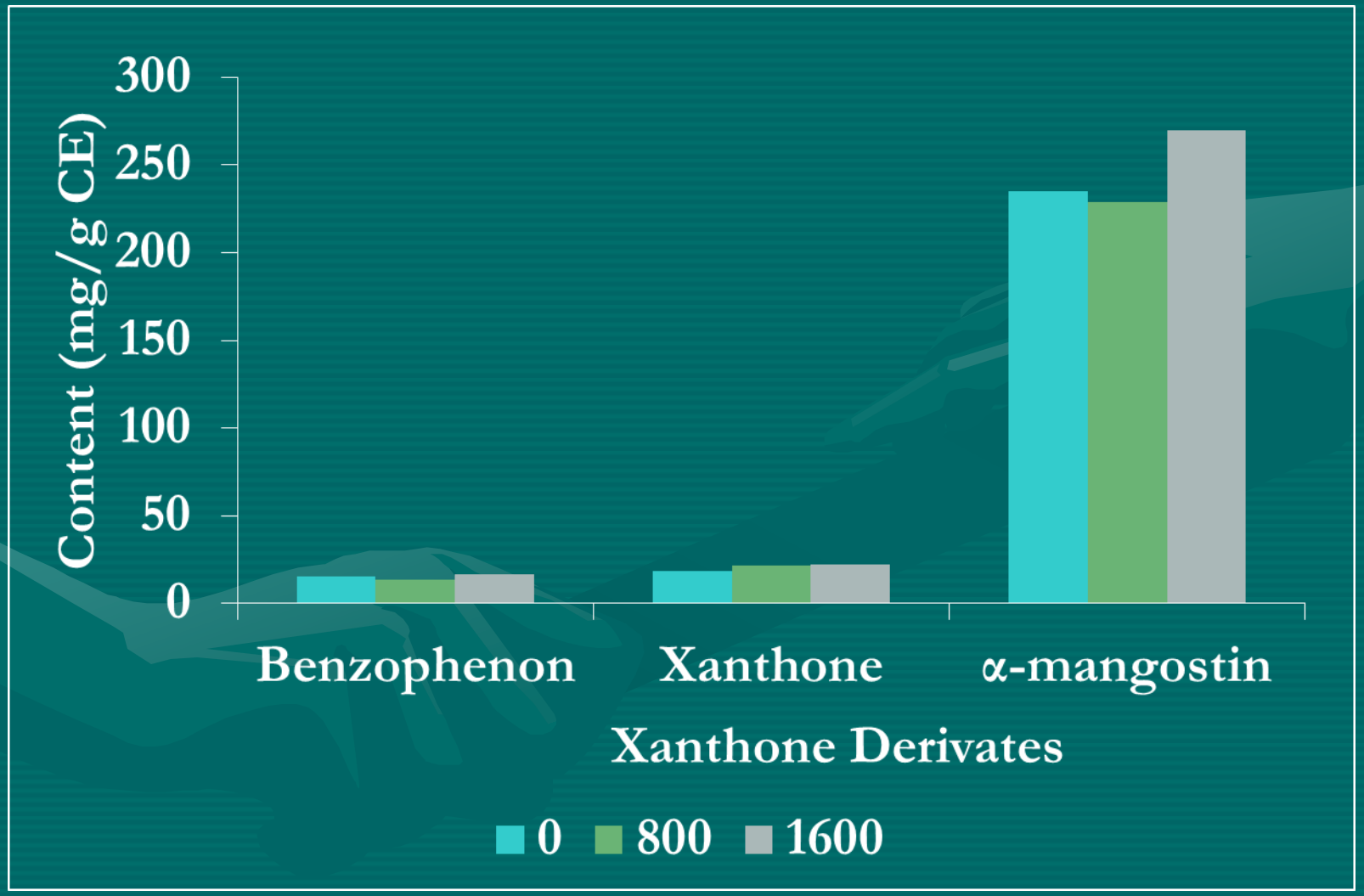
Effects of P Fertilizer on Mangosteen Xanthones



Effects of N Fertilizer on Mangosteen Xanthones



Effects of K Fertilizer on Mangosteen Xanthones



Mechanisms of Action

Clevidence, B. (2004)

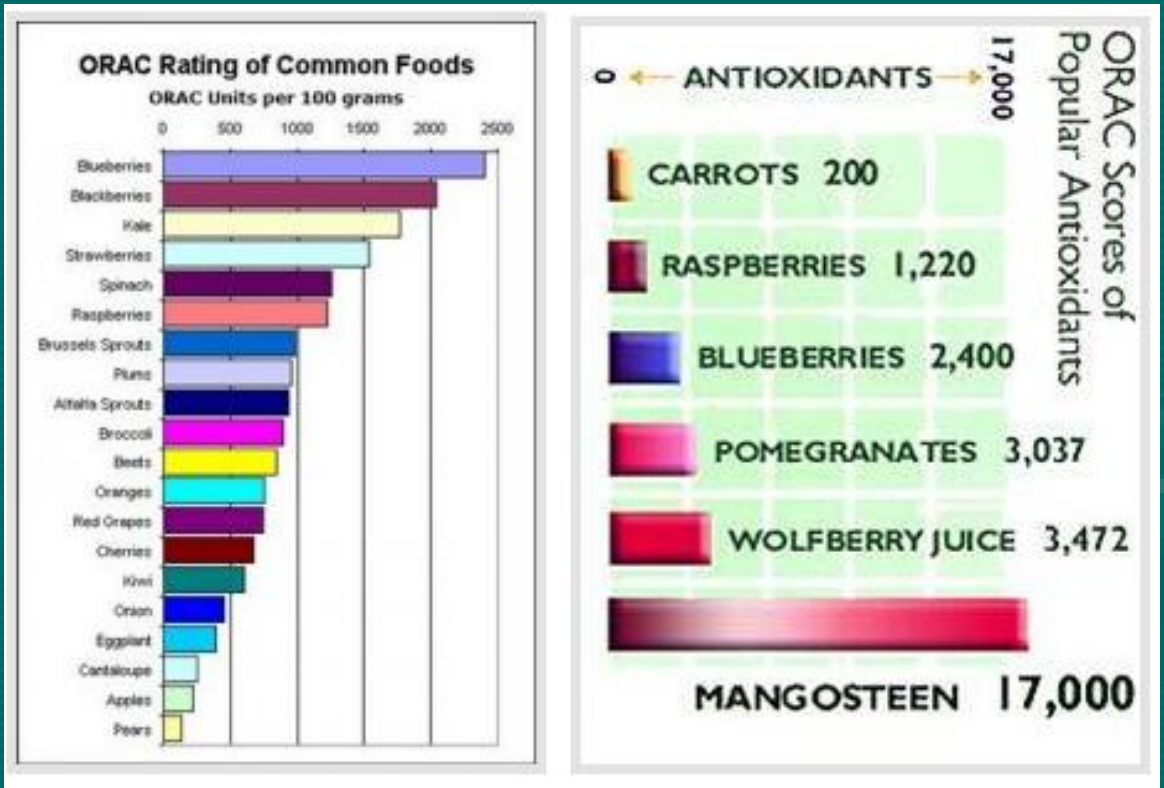
1. **Antioxidant activity**
2. Anti-angiogenesis
3. Anti cancer properties
4. Control cell growth
5. Cell-to-cell communication
6. Anti-bacterial

This protection can be attributed to phytonutrient in fruits

Anti-oxidant Potential of Mangosteen Hull Crude Extract

Fruit Age (MAA)	IC_{50} Metode		
	Ferric thiocyanate (ppm)	DPPH (ppm)	
1	74.93	6.31	c
2	75.36	6.79	c
3	77.08	9.57	b
4	71.70	12.81	a
α-tocoferol	34.93	10.34	

TAC (*Total Antioxidant Capacity*) based on ORAC (Oxygen Radical Absorbance Capacity) test



- Magozai®: 102 570 TE/l
- Xango®: 34 000 TE/l
- Tahitian Noni Juice®:18 000 TE/l
- Himalayan Goji Juice®: 19 000 TE/l

Properties of mangosteen peel

(claim by drug/jamu companies)

- Anti Bacteria
- Lowering Blood Sugar Levels
- Lowering Total Blood Cholesterol
- Preventing Heart Disease
- Preventing Aging
- Overcoming Tumor and Cancer
- Overcoming Gout
- Overcome Thyroid Disorders
- Hemorrhoid remedy
- Essential for fatigue

Properties of mangosteen peel

(claim by drug/jamu companies)

- Nourish the body cells from cancer initiation and tumor growth
- Eliminate pain in the body and joints
- Beautify and soften skin, smooth ageless skin free of acne
- Facilitate smooth bowel movements
- Good for women manapouse
- Good for people with diabetes
- Treating high blood presure, heart, uric acid and rheumatism
- Etc, etc, etc

Mangosteen peel extract Consumption Could Reduce The Incidence of Various Malignancy

(claim by drug/jamu companies)

- Leukeumia
- Breast Cancer
- Kidney Failure
- Colon Cancer
- Brain Cancer
- Liver Cancer
- Diabetes Mellitus
- Gangrene
- Glaucoma
- Cholesterol
- Triglycerides
- Stroke
- Uric Acid
- Inflammation
- Sinusitis
- Pneumonia
- Migraine
- Osteoporosis
- Insomnia
- Prostate
- Lupus
- Typhoid
- Diarrhea
- Asthma
- Lymph Nodes
- Mumps Disease
- Hemorrhoids And Ambien
- Liver and Gallbladder
- Muscle Coordination
- Appendix Complication
- Dysmenorrhea
- Whitish
- Scarlet Fever

Results of scientific research on mangosteen

- **Antioxidant (Herry, 2006;** Kurniawati, 2011; Moongkarndi *et al.*, 2004; Steinmetz & Potter, 1996; Sun *et al.*, 2004; Yang *et al.*, 2009**)**
- **Anti cancer (**Shan *et al*, 2011; Sun *et al.*, 2004; Moongkarndi *et al,* 2004**)**
- **Anti inflamation (**Moongkarndi *et al.*, 2004; Steinmetz & Potter, 1996; Yang *et al.*, 2009)
- **Anti-allergy** (Steinmetz & Potter, 1996; Yang *et al.*, 2009)
- **Anti bacteria (**Suksamrarn *et al*, 2003; Steinmetz & Potter, 1996; Yang *et al.*, 2009**)**
- **Anti-fungal** (Steinmetz & Potter, 1996; Yang *et al.*, 2009)
- **Anti-viral activities** (Steinmetz & Potter, 1996; Yang *et al.*, 2009)

People responses

- Xanthone has been claimed to have a very high potential for human health.
- These product is popular due to their perceived role in promoting health.
- There have been many companies that manufacture drugs and herbal extracted from mangosteen peel.
- There needs to be a scientific study on the efficacy of xanthones

Health products origin from mangosteen

Trade and Distribution

- Multi Level Marketing:
  - Xango
  - Magozai
  - Xamthon, etc.
- TV advertisement:
  - Garcia
- Distribution through pharmacies and drug stores

In Shan *et. all.* (2011)report

- Mangosteen products are now one of the top-selling botanical dietary supplements [Marcason, 2006].
- In 2005:
  - these products ranked sixth in single-herb dietary supplement sales,
  - netting more than $120 million,
  - a substantial increase compared to the previous year [Garrity *et al.*, 2004; Foote, 2007].

Results of Veronica Leigh Johnson Survey in USA 2011

- Consumers are more concerned with their health
- 66% of respondents saying they are willing to pay more for "super fruits"
- 51% believe that "super fruits" have superior health benefits than other fruits
- The target market for "super fruits" was females, with the age range being anywhere from 18-44 years old, who are moderately to highly educated
- Consumer valuing the healthy factors and the taste of the fruit itself over price or growing location.
- As long as it tastes good and is good for health, they're buying.

Conclusion

- Based on our reseach that:
  - Location, variety, fertilization, fruit age, fruit chareacters, and storage influenced xanthone contents and its antioxidant potential
  - the drug companies should employing standart operation procedures in mangosteen plantation for xanthone production
  - in order to get standarize drug/jamu/herbal/health products

Conclution

- Research on the effects of xanthone on human healts is very importants
  - Is a high ORAC (antioxidants test) on xanthone good for human health? It should be proven.
  - Promotion of the herbal property should based on scientific evidence
- Consumer believe that herbal from mangosteen fruit have superior health benefits, but they are also concerned with the taste of the product

Thank you for your attention