The Nutrition and Health Benefits of Tropical Fruits with Special Reference to Red Pitaya

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Outline of Presentation

- Introduction
- Research Objectives
- Nutrient Composition
- Animal Study
- Human Intervention Trial
- Discussion
- Conclusion

Red Pitaya Fruit

INTRODUCTION

- Fruit and vegetables are rich source of a variety of nutrients including vitamins, trace minerals, dietary fiber and many other classes of biologically active compounds.
- WHO suggested that intakes of at least 400g/day of fruits and vegetables may protect against chronic diseases.

- According to Dianne, 2001 reported that there was a 4% lower risk of coronary artery disease for each 1 serving per day increase in fruit and vegetable intake in a combined study of Nurses' Health study and men in the Health Professionals' Follow-Up study.

- The World Health Organization (WHO) reports that high cholesterol contributes to 56% of cases of coronary heart disease worldwide and causes about 4.4 million deaths each year.

- By 2020 heart disease and stroke will become the leading cause of both death and disability worldwide, with the number of fatalities projected to increase to more than 20 million a year and to more than 24 million a year by 2030 (Atlas of Heart Disease and Stroke, WHO, September 2004).

- At the drawn of the new millennium in 2000, in Malaysia, 12,412 Malaysian men and 9,746 Malaysian women lost their lives to cardiovascular diseases, accounting for 19.2 % of all male deaths and 21.2 of all female deaths in Malaysia in that year.

- In 2001, approximately 20% of all deaths at the Ministry of Health hospitals were due to heart attacks and strokes. Two thirds of these deaths were due to heart diseases and the rest to strokes (Dhanoa, 2004).

- Risk factors for CHD are:

- Sex, Age, Genetic
- **HYPERCHOLESTEROLEMIA**, smoking, sedentary lifestyle, stress, hypertension, diabetes mellitus, obesity

- Hypercholesterolemia can cause various complications:

- Increased risk related to artery disease
- Narrowing of arteries
- Weaken heart muscle
- Reduced artery elasticity
- Hypertension

- Many clinical and epidemiological studies have looked at the relationship between elevated cholesterol levels, increased risk for heart attack and death.

- Changing dietary habits by reducing the amount of fat and cholesterol consumed is advised in prevention of any complication of cardiovascular diseases.

- In epidemiological studies, researchers have strongly suggested that diet plays an important role in prevention of chronic disease (Bauman, 2004; Parillo & Ricardi, 2004).
- There is evidence saying that lowering the cholesterol level by 1% will also contributes to reduce the risk of getting cardiovascular disease by 2% (Hershey, 2004).

- Many medicine/drugs can be found in the market that may be used to lower the blood cholesterol level, but recent studies have added to the growing evidence that the fruit and vegetable intake reduces risk factors as well as incidence and mortality associated with CVD.

- Fruit and vegetable intake increases antioxidant capacity of plasma in a short time after consumption that made it as a protective effect to prevent CVD (Dianne, 2001).

- A study by Vilasinee *et al.* (2006) where administration of Roselle to hypercholesterolemia rats that were induced by daily intragastric administration of cholesterol (2 g/kg) dissolved in corn oil showed positive results.
- Consumption of Roselle at 500 and 1000 mg/kg significantly indicates a decreased serum triglycerides level by about 13% and 11%, respectively, after 4 weeks of treatment and these triglycerides levels were significantly lower than those in the untreated hypercholesterolemic rats.

- Plant products such as fruit, have many beneficial health effects to prevent from chronic diseases through our diet. Epidemiological studies have strongly suggested that diet plays an important role in the prevention of chronic diseases (Bauman, 2004; Parillo & Riccardi, 2004).

RESEARCH OBJECTIVES

- To determine nutrient composition of tropical fruit (red pitaya fruit)
- To assess hypocholestrolemic effect of red pitaya fruit in animal model
- To evaluate hypocholesterolemic effect of red pitaya fruit consumption among hypercholesterolemic subjects

NUTRIENT COMPOSITION

- Fruits contain combination of nutritional value such as vitamins, minerals, fiber, antioxidant, phytochemical.
- Proximate analysis of vitamin, mineral, dietary fiber were carried out in red pitaya fruits using AOAC approved methods.

Preparation of Sample

- Fruits were washed, cleaned and skin removed
- Sample of fresh fruits were used for determination of moisture, ash, β-carotene and ascorbic acid
- “freeze-drier” form of fruit were used for dietary fiber analysis

Methodology

- Moisture, ash, β-carotene and ascorbic acid was analyzed according to Tee et al. (1996)
- Mineral such as Ca, K, Na, Fe, Zn, Mg and Cu determined from ash sample using ‘flame’ AAS system (Tee et al., 1996)
- Total dietary fiber (TDF), soluble dietary fiber (SDF) and insoluble dietary fiber (ISF) were analyzed using enzymatic-gravimetric method (Prosky et al. 1992)

Nutrient Composition of Red Pitaya Fruit

Ingredients (in 100 grams)	Amount (unit)
Moisture	87.3±0.02 (g)
Ash	0.7±0.03 (g)
Protein	0.16±0.02 (g)
Fat	0.23±0.03 (g)
Carbohydrate	1.48±0.15 (g)
Crude fiber	10.1±0.25 (g)
Calcium	5.7±0.08 (mg)
Phosphorus	23±0.04 (mg)
Magnesium	28.3±0.97 (mg)
Sodium	50.15±0.1 (mg)
Potassium	56.96±0.02 (mg)
Iron	3.4±0.25 (mg)
Zinc	13.87±0.65 (mg)
Copper	0.031±0.004 (mg)
Thiamin	48.9±1.56 (µg)
Riboflavin	40.75±3.47 (µg)
Niacin	513.78±6.53 (µg)
Pyridoxine	20.57±2.23 (µg)
Cobalamin	15.61±1.89 (µg)
Ascorbic acid	525.32±3.09 to 540.27 (mg)
Vitamin A	120.13± (µg)
Vitamin E	105.67± (µg)
Lycopene	14.35± (mg)

Sources:
(a) Mohd Azim K.R.
(b) Norhayati A.H. (2006)

Flavanoids Content of Red Pitaya Fruit

Ingredients (in 100 grams)	Amount (unit)
Kaempferol	3.09±0.26 (µg)
Myricetin	7.23±0.86 (µg)
Quercetin	6.81±0.76 (µg)
Apigenin	2.01±0.18(µg)
Luteolin	1.06±0.11 (µg)
Rutin	1.03±0.09 (µg)

Sources:
Mohd Azim K.R. (2006)

ANIMAL STUDY

Methodology (IN-VIVO STUDY)

- This study was done using 60 *Sprague Dawley* male rats and was divided into six groups (n=10 for each group).

Location:

- This study was carried out in Animal Laboratory Unit, Faculty of Medicines and Health Sciences, Universiti Putra Malaysia (UPM) and was given approval from ethical committee for animal study in the faculty.

Study Period:

- This study consisted of 2 weeks for adaptation, 4 weeks for inducing hypercholesterolemia, 6 weeks for treatment.

Study Design

Control Groups

1 (N)

2 (K)

Treatment Groups

3 (K)

4 (K)

5 (K)

6 (K)

Induced Hypercholesterolemia with 1% Cholesterol and 0.1% Cholic Acid (3^{rd}, 4^{th}, 5^{th} & 6^{th} week)

Treatment Week (7^{th} - 12^{th} Week)

Killed

Hypercholesterolemia was induced by adding 1% Cholesterol and 0.1% Cholic acid in the experimental diet (basal diet)

Study Groups

- N = Normal (Negative control)
- K = Hypercholesterolemic (Positive control)
- 3K= Hypercholesterolemic + 300g pitaya fruit
- 5K= Hypercholesterolemic + 500g pitaya fruit
- 7K= Hypercholesterolemic + 700g pitaya fruit
- L = Hypercholesterolemic + 0.083mg Lovastatin drug.

Type of diet & treatment for rats according to groups

Group	Diet	Treatment
1 (N)	Basal diet	None
2 (K)	Basal diet + 1% cholesterol + 0.1% cholic acid	None
3 (K)	Basal diet + 1% cholesterol + 0.1% cholic acid	0.163g pitaya *
4 (K)	Basal diet + 1% cholesterol + 0.1% cholic acid	0.271g pitaya *
5 (K)	Basal diet + 1% cholesterol + 0.1% cholic acid	0.379g pitaya *
6 (K)	Basal diet + 1% cholesterol + 0.1% cholic acid	0.083mg Lovastatin*

*According to mean body weight of rats

Calculation of Pitaya Fruit Given (g) to Rats Equivalent to Human Consumption

- **Calculations:**

Treatment with 300g pitaya needed by individual weight 60000g or 60kg (Average human weight):

If weight of rat is 250g, therefore -

Pitaya (wet weight) = 250g x 300g/60000g

= 1.25g

Due to 87% lost of weight due to drying effect using freeze-drying, so dry weight left for 1.25g wet pitaya is:

Pitaya (dry weight) = 1.25 x 13%

= 0.1625g per rat

Same calculation for 500g and 700g pitaya fruit equivalent to human consumption

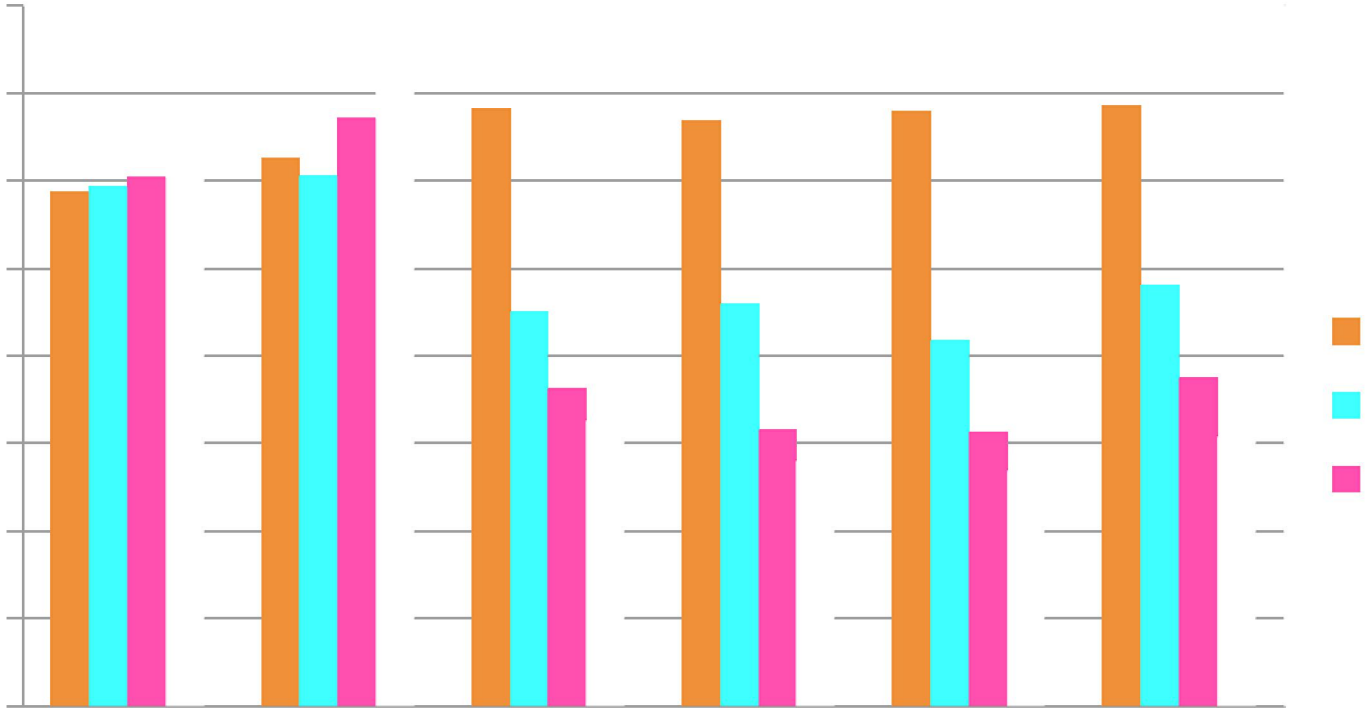
Data Collection

- Body weight of rats monitored throughout the study.
- Fasting blood samples were collected through cardiac punctured during baseline and every treatment weeks.
- Plasma lipid profiles were analyzed enzymatically using C*hemical Auto-Analyzer for:*

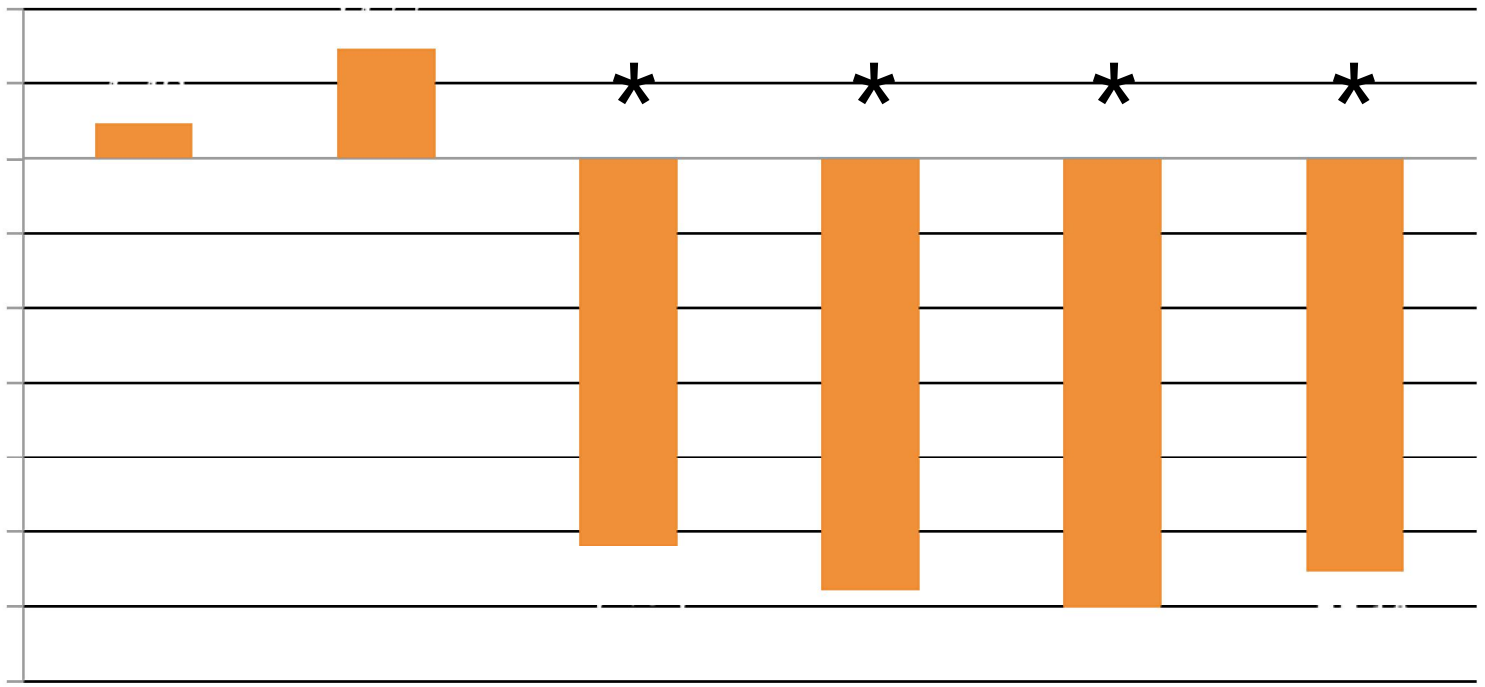
- Total cholesterol (TC)
- Low Density Lipoprotein cholesterol (LDL-C)
- High Density Lipoprotein cholesterol (HDL-C)
- Triglyceride (TG)

Results of Animal Study

- **Changes in mean plasma TC according to groups throughout study period**

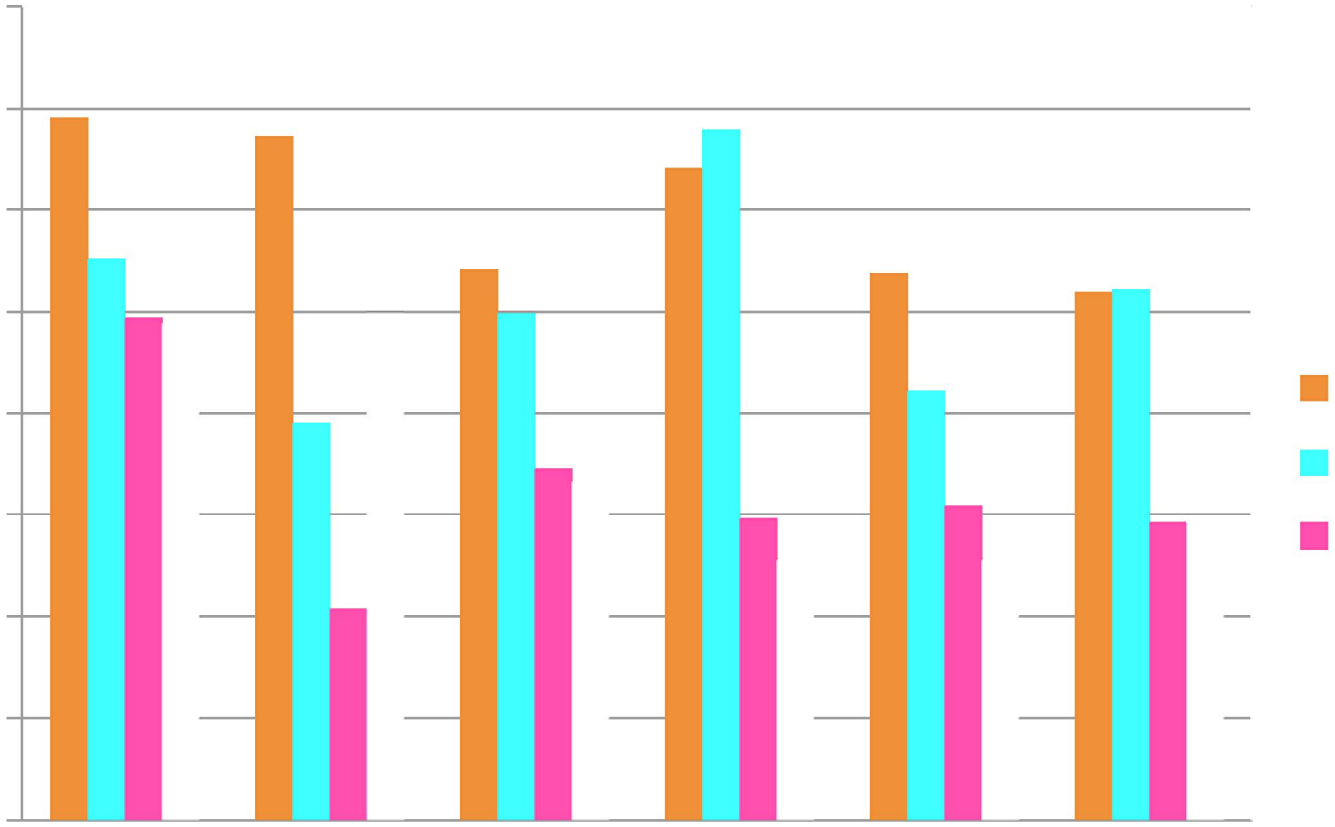


Comparison of percentage changes in plasma TC level of rats before and after the treatment



*** indicates significant different at level of p<0.05**

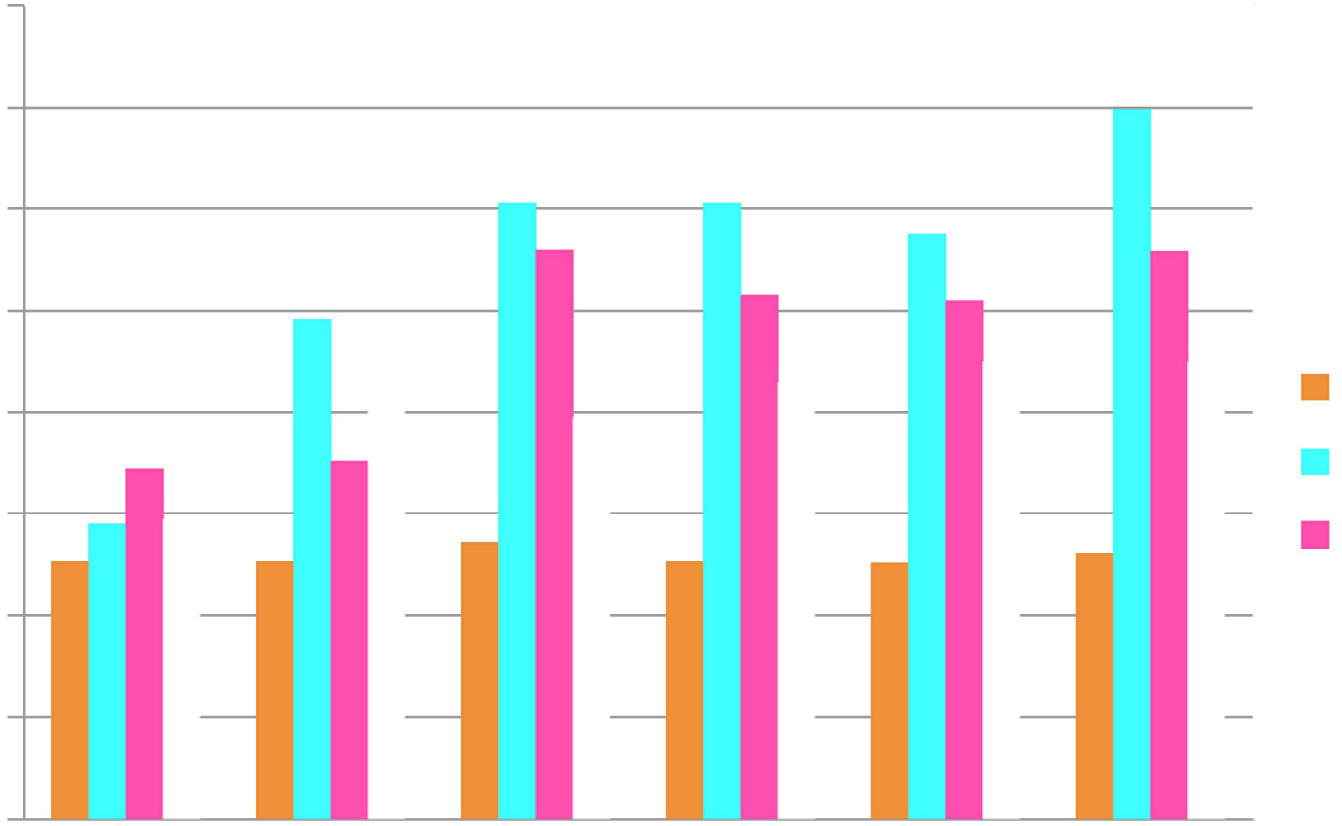
- **Changes in mean plasma TG according to groups throughout study period**



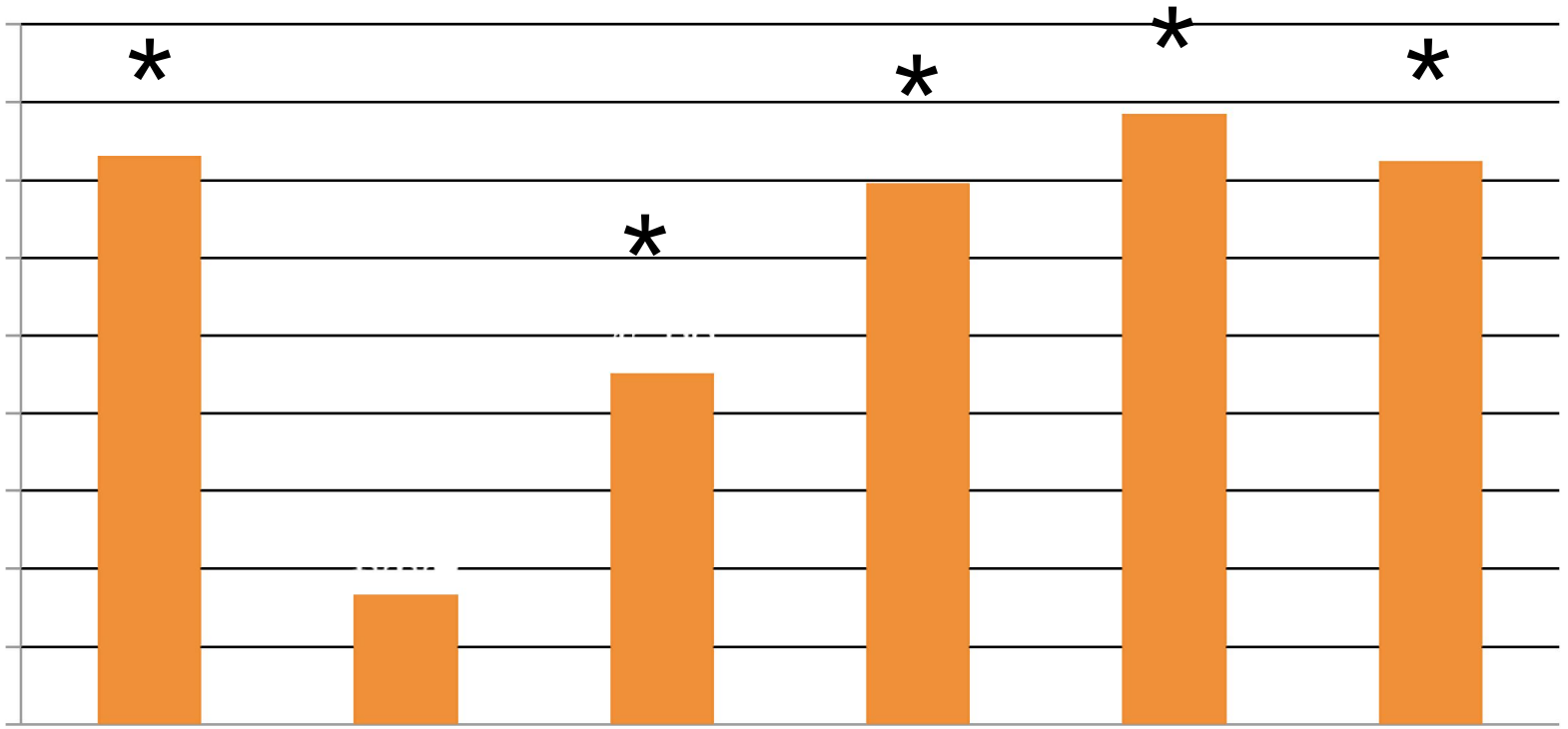
Comparison of percentage changes in plasma TG level of rats before and after the treatment

*** indicates significant different at level of p<0.05**

- **Changes in mean plasma HDL-C according to groups throughout study period**

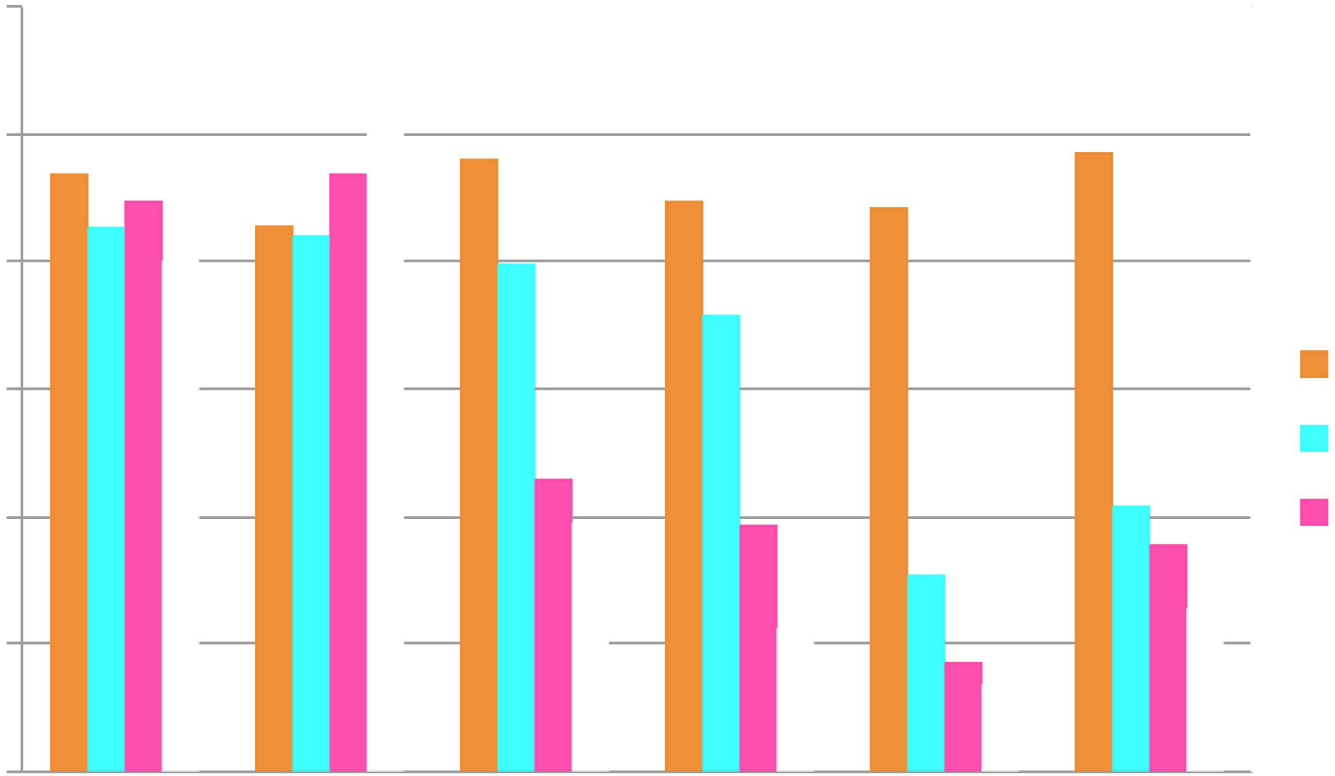


omparison of percentage changes in plasma HDL-C level of rats before and after the treatment

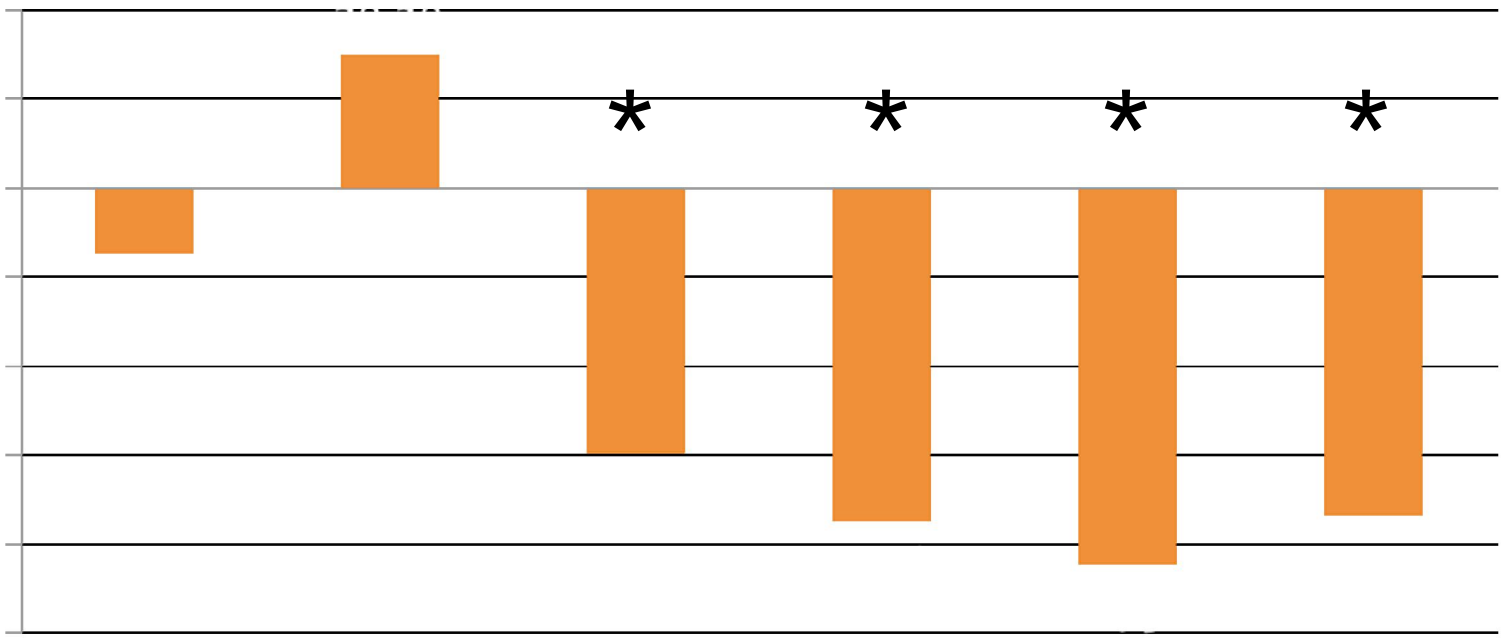


*** indicates significant different at level of p<0.05**

- **Changes in mean plasma LDL-C according to groups throughout study period**



omparison of percentage changes in plasma LDL-C level of rats before and after the treatment



*** indicates significant different at level of p<0.05**

Summary

- **Changes in mean plasma lipid profiles according to the group after 6 weeks of treatment**

Lipid Profiles	Groups					
	N	K	3K	5K	7K	L
TC	↑	↑	↓	↓	↓	↓
TG	↓	↑	↓	↓	↓	↓
HDL-C	↓	↑	↑	↑	↑	↑
LDL-C	↓	↑	↓	↓	↓	↓

- After 6 weeks of treatment, **plasma Total cholesterol** level has shown a **reduction** in all groups except for N and K groups.
- After 6 weeks of treatment, **plasma Triglyceride** level has shown a **reduction** in all groups except for group K.
- After 6 weeks of treatment, **plasma HDL** cholesterol level has shown an **increased** in all groups except for group N.
- After 6 weeks of treatment, **plasma LDL** cholesterol level has shown a **reduction** in all groups except for group K.

Other Studies

- Epidemiological studies have shown that high dietary fiber intake have shown a strong influenced on the incidence of chronic diseases (Fraser, 1994).

- Dietary fiber has a positive effect on the serum cholesterol level (Anderson et al., 1994)

- Interfere with cholesterol metabolism and regulation at the absorption, biosynthesis and catabolism stages (Jenkins et al., 1993).

HUMAN TRIAL STUDY

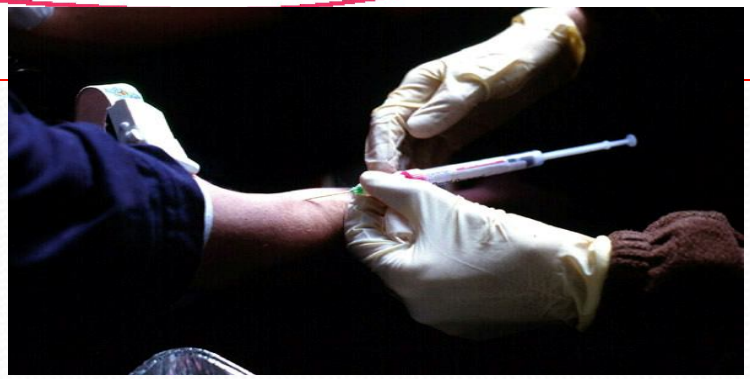
Methodology

- **Location:** Faculty of Medicines and Health Sciences, Universiti Putra Malaysia (UPM).
- **Subject:** Staff and students of Universiti Putra Malaysia
- **Study Period:** consisted of

  2 weeks for screening and identify the respondent,

  4 weeks for treatment and blood sampling,

  2 weeks for washout period.



- **Selection criteria**:

  age: 25-55 yrs

  hypercholesterolemia (>5.2 mmol/L)

  healthy, no medication taken

  willing to consume pitaya fruit

  volunteered and signing of consent letter

- This research was approved by *Medical Research Ethic Committee* at the Faculty of Medicine and Health Sciences.
- All subjects were advised to take normal diet and carried out usual physical activity

Study Design:

- Subject was divided into two groups which were Intervention group and Control group.
- Intervention group - consisted of 2 groups,

  Group 1 - consumed 600g of fresh pitaya fruit

  Group 2 - consumed 400g of fresh red pitaya fruit.
- Control group - consisted of 2 groups

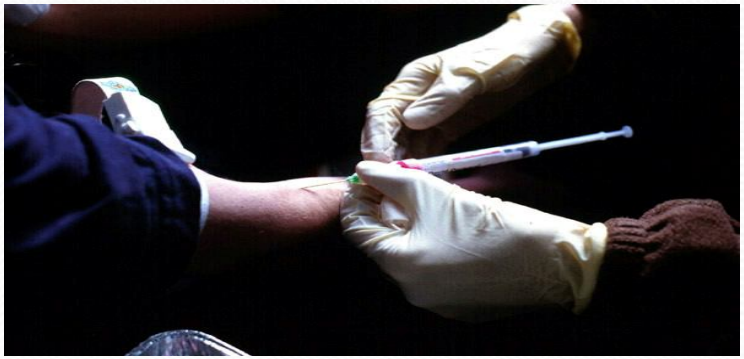
  Group 3 – positive control (Hypercholesterolemia)

  Group 4 – negative control (Normal)
- Both of control groups were not given pitaya fruit.

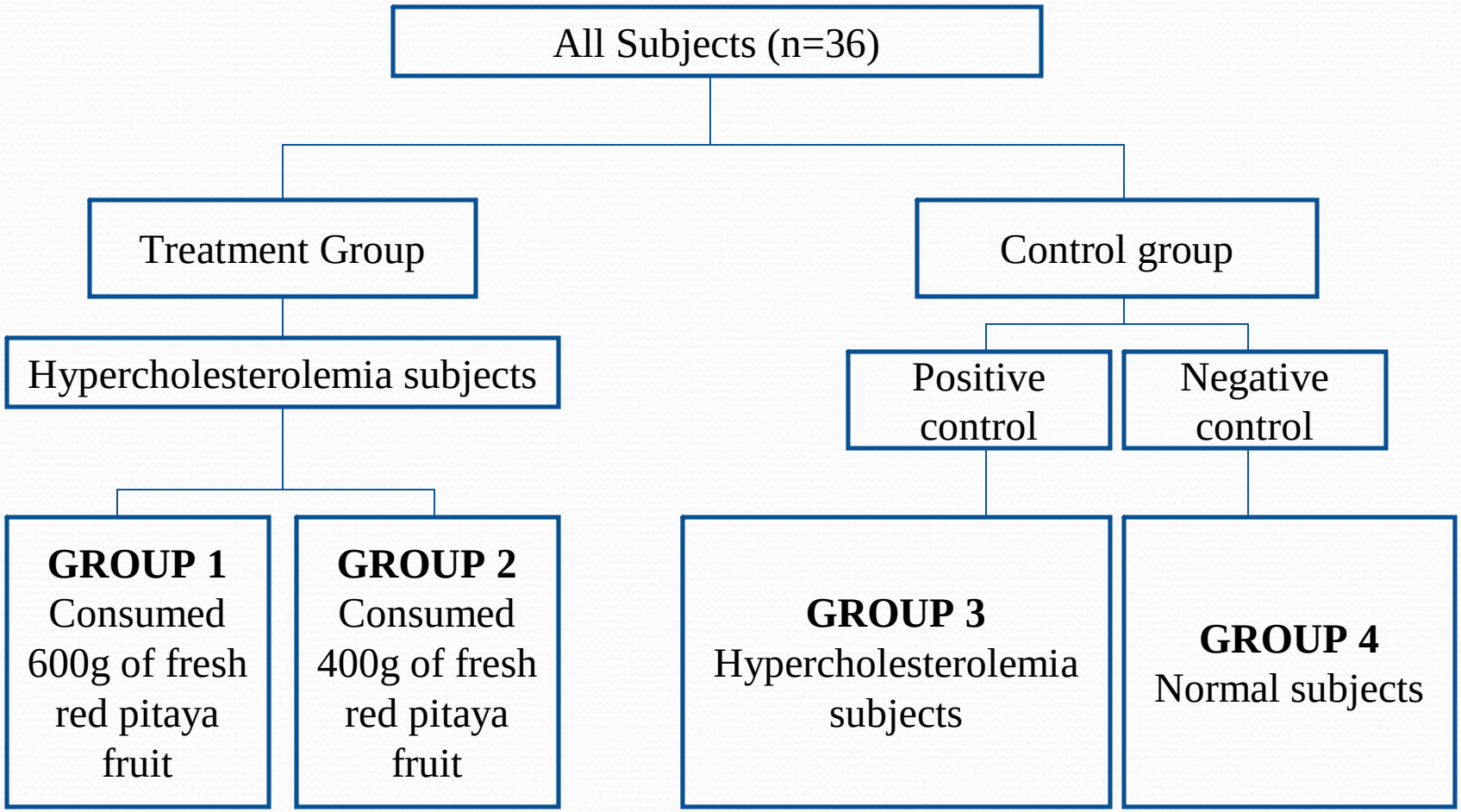
- Rational-

  - To compare the lipid profiles level between hypercholesterolemia subjects and normal subjects.

  - To compare the hypocholesterolemic effect between the treatment groups and normal group either their lipid profiles level reach the level of normal subject or not.



Study Design

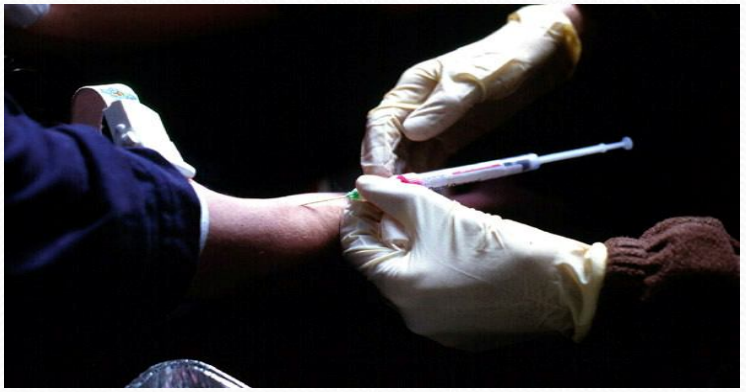


Study Groups

- GROUP 1= Hyper TC + 600g pitaya fruit + normal diet
- GROUP 2 = Hyper TC + 400g pitaya fruit + normal diet
- GROUP 3 = Hyper TC + no pitaya + normal diet
- GROUP 4 = Normal TC + no pitaya + normal diet

Data Collection

- 1. Background information
- 2. Anthropometric measurement
- 3. 24 hours dietary food recall
- 4. Lipid profile - fasting blood



Background Information of Subjects (n=36)

Parameter	Number	Percentage (%)	Min±S.D
Age (Year)			**40.67±10.99**
21-30	8	22.2	
32-40	6	16.7	
41-50	12	33.3	
51-56	10	27.8	
Gender			
Male	15	41.7	
Female	21	58.3	
Ethnic			
Malay	32	88.8	
Chinese	1	2.9	
Indian	3	8.3	
Religion			
Islam	32	88.8	
Buddha	1	2.9	
Christian	3	8.3	

Status			
Single	8	22.3	
Married	25	69.4	
Widow	0	8.3	
Salary (RM)			**1947.95±1752.93**
0	4	11.1	
<1000	3	8.3	
1000-2999	25	69.4	
3000-4999	0	0	
≥5000	4	11.1	
Educational level			
Lower	3	8.3	
SRP/LCE	3	8.3	
STPM/MCE	12	33.4	
Diploma/Degree	14	38.9	
Master/PhD	4	11.1	

Anthropometry Measurement

Classification	Group 1	Group 2	Group 3	Group 4	Total
Underweight (BMI<18.5)	**0**	**0**	**0**	**0**	**0**
Normal (BMI>18.5-24.9)	**6**	**2**	**1**	**6**	**15**
Overweight (BMI>25.0-29.9)	**5**	**6**	**2**	**1**	**14**
Obesity (BMI>30)	**2**	**3**	**2**	**0**	**7**
	13	**11**	**5**	**7**	**36**

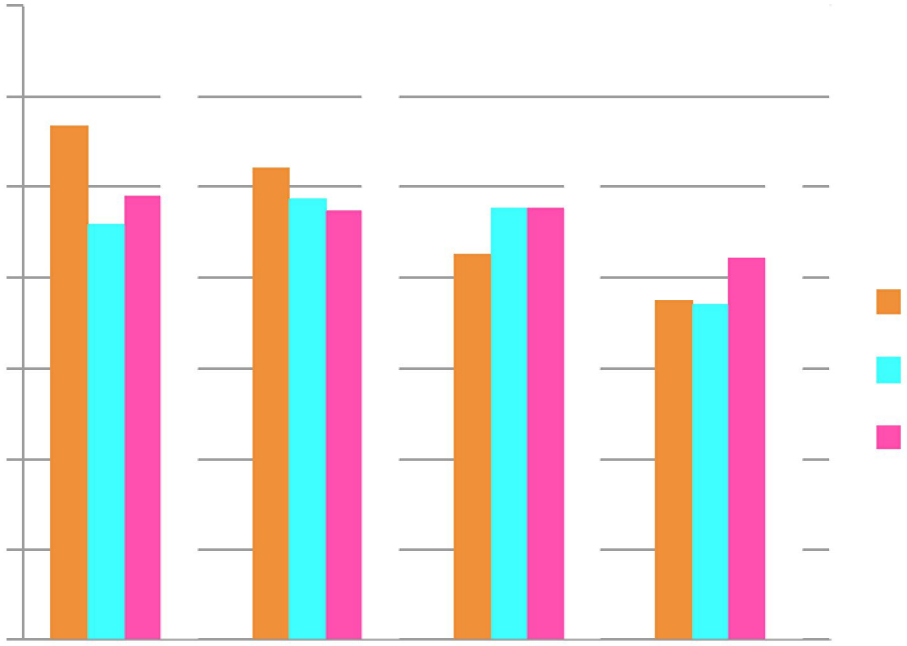
Subject's BMI according to group (n=36)

Average Nutrient Intake of Subjects

Type of Nutrient	Min±S.D	RNI achievement (%)
Energy (Kcal)	2030±87.9	77.5
Protein (g)	77.51±16.87	129
fat (g)	56.67±17.95	-
Cholesterol (mg)	240.5±155.01	-
Fiber (g)	12.42±6.26	-
Carbohydrate (g)	252.83±95.44	-
Vitamin A (µg RE)	1757.07±542.09	351.3
Vitamin C (mg)	84.5±61.99	117.8
Calcium (mg)	518.01±246.06	66.6
Thiamin (mg)	1.172±0.3	100.1
Riboflavin (mg)	3.46±6.95	101.9
Niacin (mg)	19.74±6.25	133

Results on Lipid Profiles

- **Changes in mean plasma TC according to groups throughout study period**

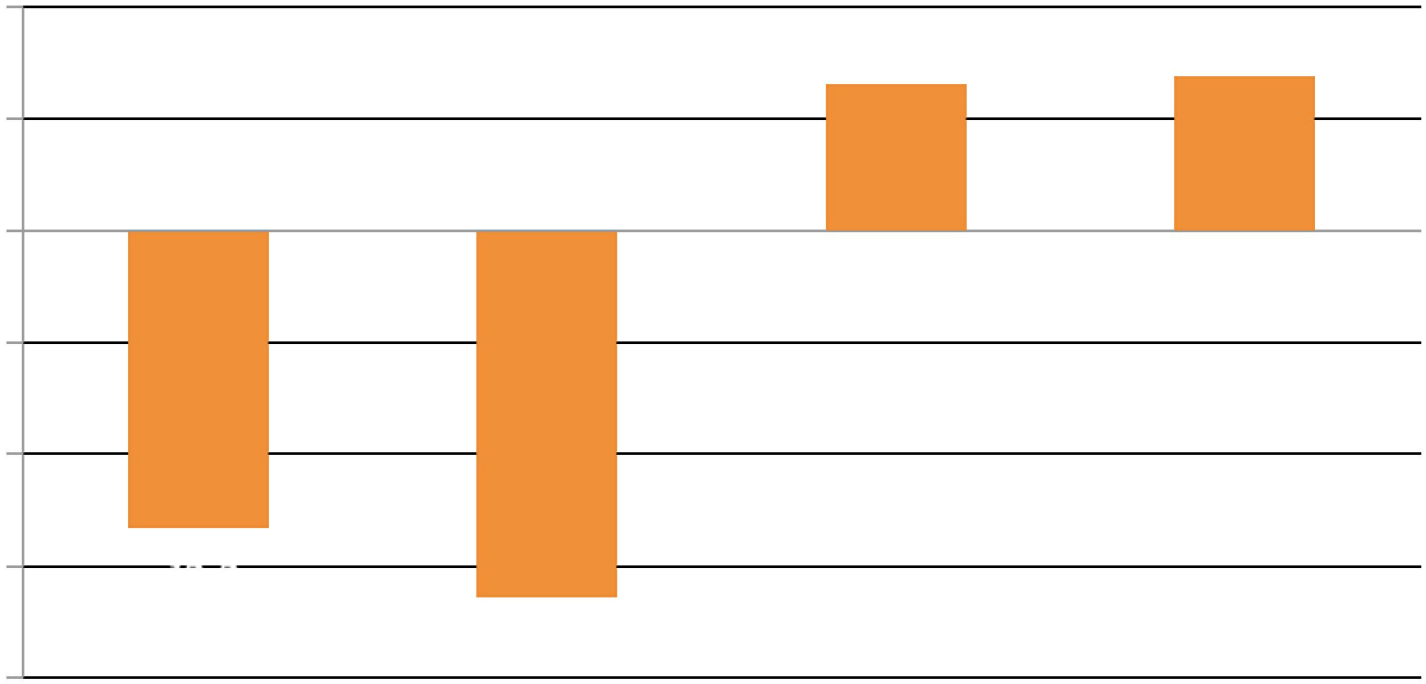


Group 1 – 600g pitaya
Group 2 – 400g pitaya
Group 3 – Positive control
Group 4 – Negative control

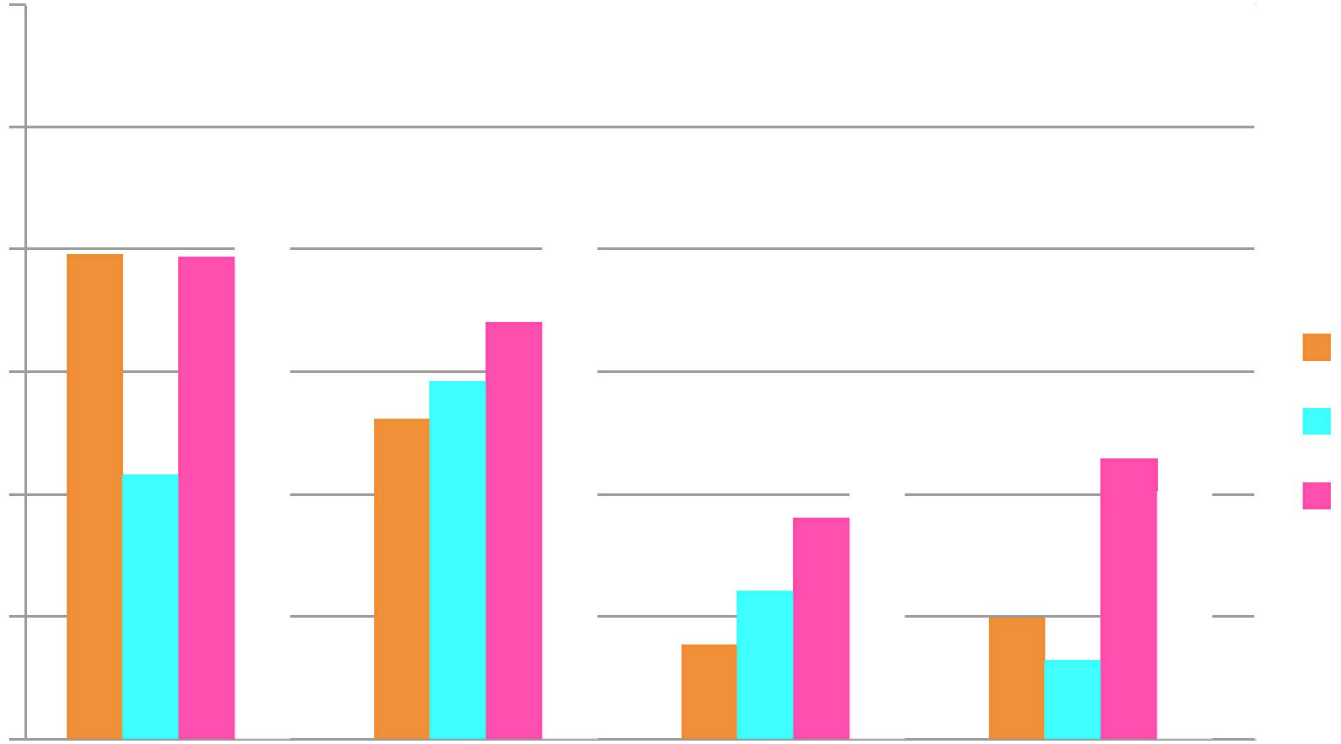
Week 1-5 – Consumed pitaya

Week 7 – Not consumed pitaya

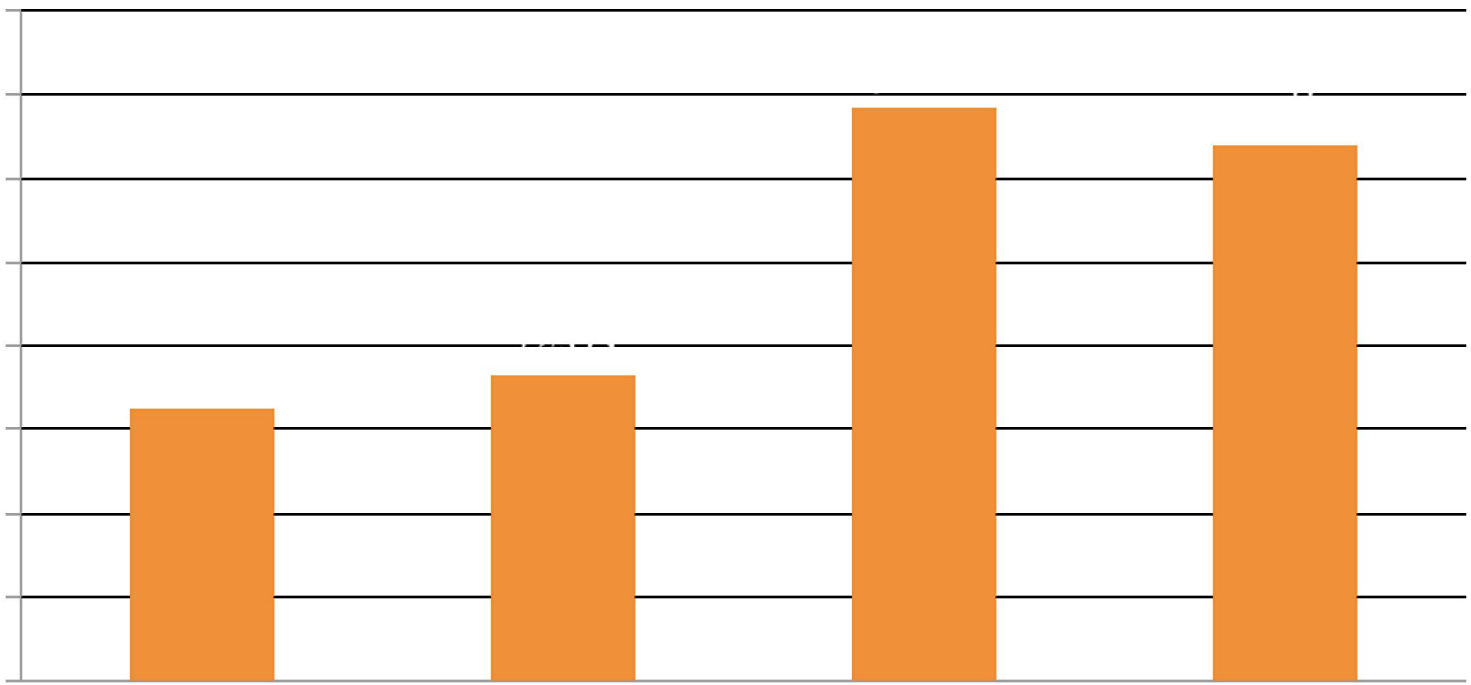
Percentage changes in plasma TC level for week 1 and week 5



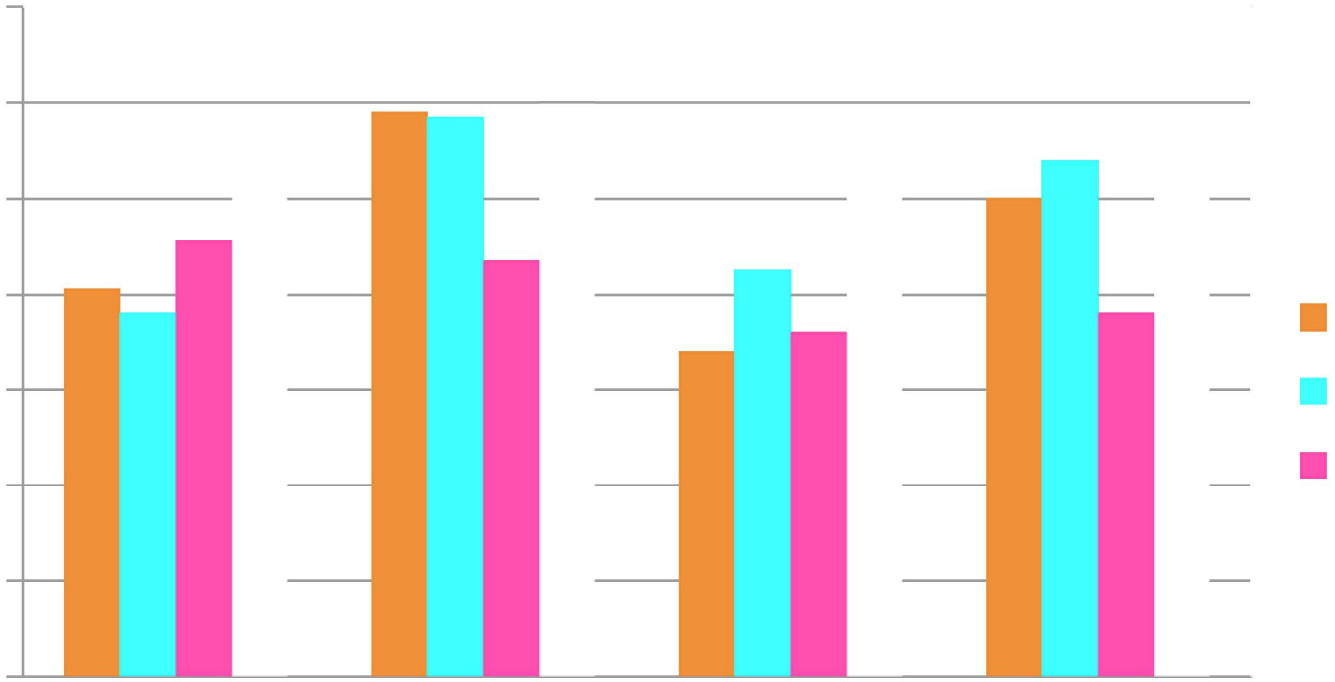
- **Changes in mean plasma TG according to groups throughout study period**



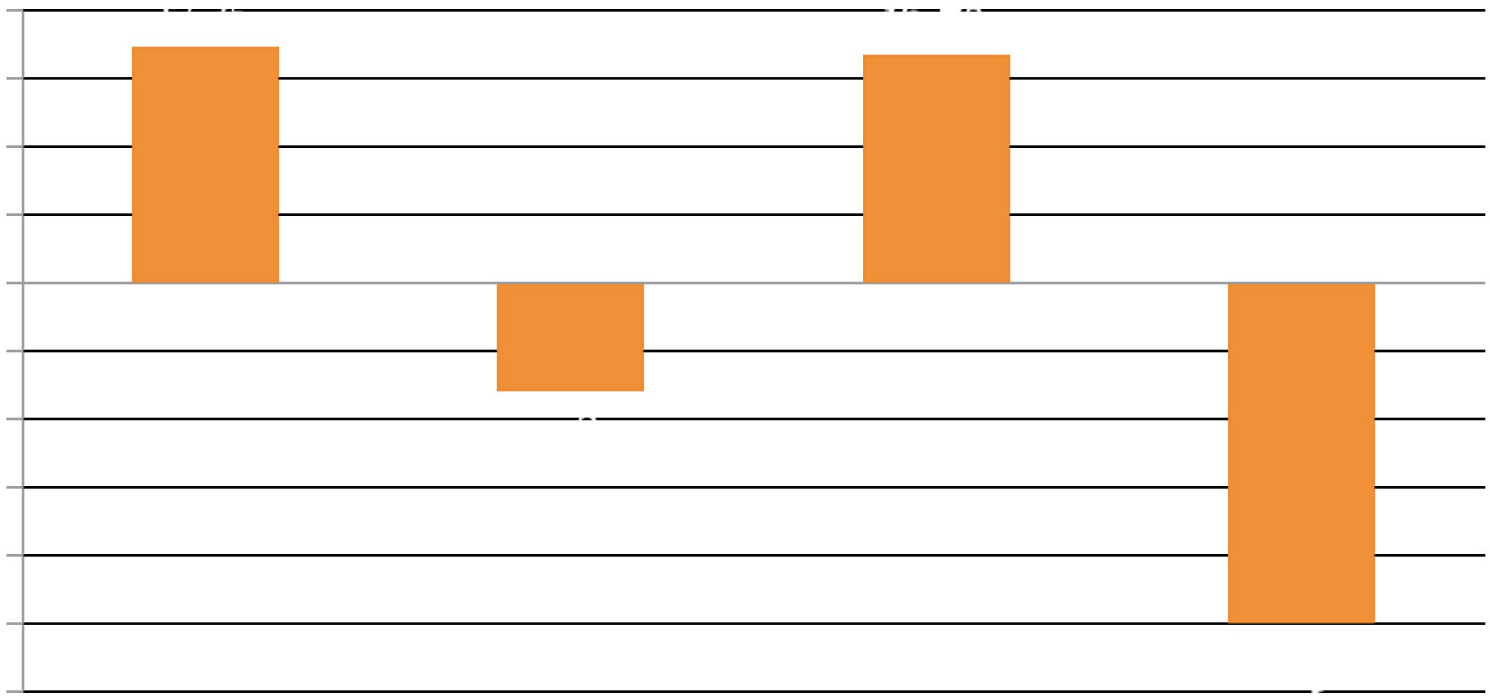
Percentage changes in plasma TG level for week 1 and week 5



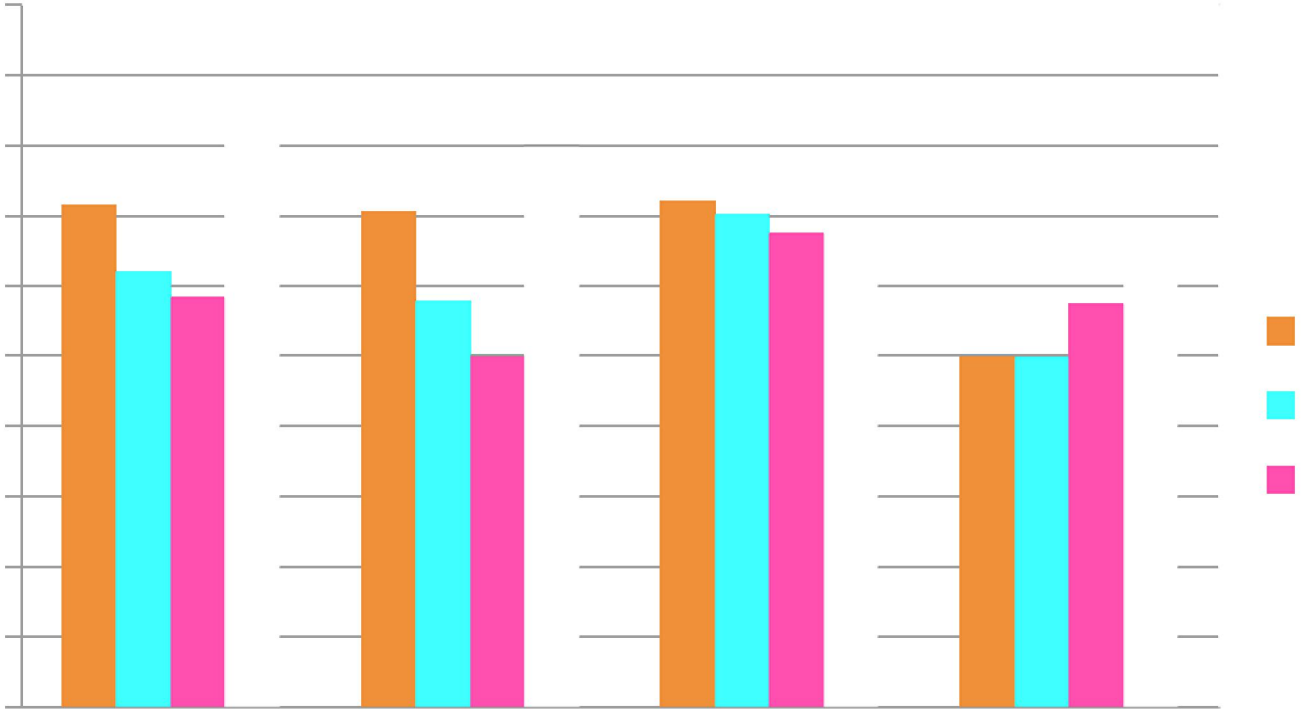
- **Changes in mean plasma HDL-C according to groups throughout study period**



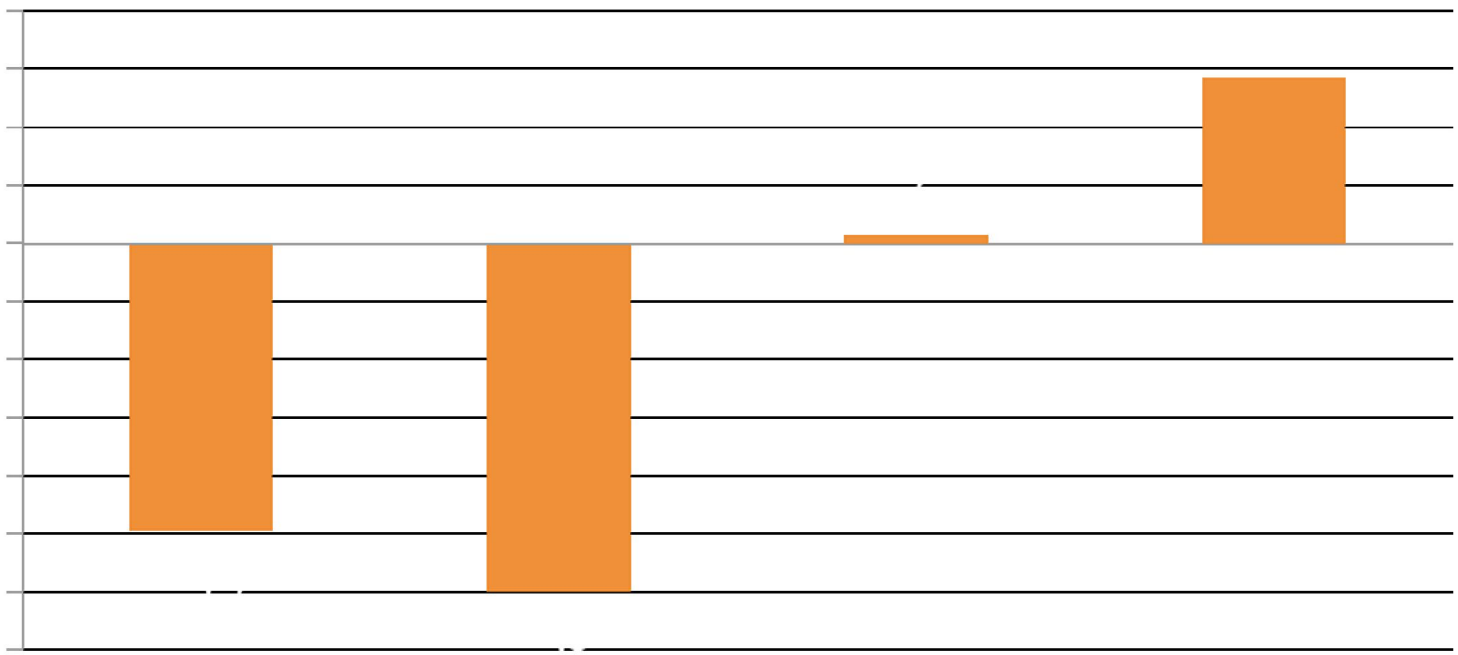
Percentage changes in plasma HDL-C level for week 1 and week 5



- **Changes in mean plasma LDL-C according to groups throughout study period**



Percentage changes in plasma LDL-C level for week 1 and week 5



Summary

- **Changes of mean plasma lipid profiles according to the group after 5 weeks of treatment**

Lipid Profiles	Groups			
	1	2	3	4
TC	↓	↓	↑	↑
TG	↑	↑	↑	↑
HDL-C	↑	↑	↓	↓
LDL-C	↓	↓	↑	↑

Comparison with other studies in tropical fruits intake

The effects of tropical fruits on human lipid profile *

	Changes in Lipid Profile (%)			
Tropical Fruits	Total cholesterol	LDL cholesterol	HDL cholesterol	Triglyceride
Guava¶ (a)	↓ 8.19	↓ 9.55%	No change	----
Papaya (b)	↓ 1.62	↓ 2.31%	↑ 0.75%	↑ 0.92%
Watermelon (c)	↓ 7.85	↓ 5.09%	↓ 1.10%	↓ 16.93%
Star fruit (d)	↓ 3.9	↓ 0.60%	↓ 10.65%	↑ 15.90%
Pineapple (e)	↓ 8.38	↓ 11.40%	↑ 14.80%	↓ 9.74%
Red pitaya (f,g,h)	↓ 13.3‡-25‡%	↓ 5.94†-28‡%	↑ 10‡-14.1†%	↓ 23.52†%

* Consumption of 500 grams/day in 4 weeks
¶ Consumption of 230 grams/day in 4 weeks
† Consumption of 400 grams/day in 4 weeks
‡ Consumption of 600 grams/day in 4 weeks

Sources:
(a)Fadhilah Binti Lamun @ Hj Jailani (1998)
(b)Noraliza bt Mohd Tamin (2001)
(c)Rohaiza Binti Rozali (2001)
(d)Suryati Muhd Alinafiah (2001)
(e)Sam Azura bt Ahmad (2001)
(f)Fazila et al. (2006)
(g)Chong et al. (2006)
(h)Marhazlina et al. (2006)

DISCUSSION

- Soluble fiber increase fecal bile acids losses and chemodeoxycholic acid synthesis and appear to be the best substantiated mechanism by which fiber lowers serum cholesterol.

- Other factors that may have contributed to the cholesterol-lowering effects are the plant sterol and phytochemical present in fruits that interfere with cholesterol metabolism

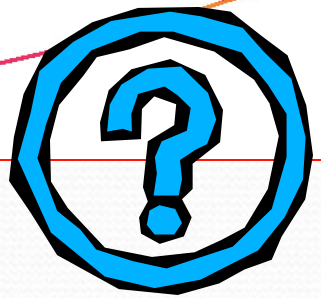
- These effects maybe attributed by the active components present in the pitaya fruit such as antioxidant, polyphenolics, thiols, and their antioxidative activity from the betacyanin contents (Wybraniec & Mizrahi, 2002).
- The present study results revealed that both treatments (Red pitaya fruit and Lovastatin drug) showed a similar effect in increasing HDL-C and lowering TC, TG and LDL-C levels.

CONCLUSION

- This study indicates hypocholesterolemic effect of tropical fruits as shown in-vivo and human intervention trial, therefore it has a potential of reducing the risk factor for CHD (dyslipidemia).
- These findings support current dietary recommendations to increase the intake of fruits and vegetables as primary preventive measure against CHD
- ↓ 1% TC level = ↓ 2% risk of CHD

Therefore 400g = 5 servings of fruits at least daily will be a good practice along with healthy lifestyle

Importance of this study



- Increase awareness among public on potential health benefits of tropical fruits
- Promote consumption of tropical fruits
- Increase acreage of tropical fruits
- Reduce rate of morbidity and mortality related to CHD through eating enough of topical fruits

Acknowledgement

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“Let food be your medicine and medicine be your food.”

“Hippocrates”

Thank you for your attention