Diskusi Ilmiah: Kelayakan Fortifikasi Vitamin A pada Minyak Goreng
SEAFAST Center-IPB
Senin, 12 Juli 2010

Stabilitas Vitamin A & β-Karoten, dan Pengembangan Minyak Sawit Merah

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Agenda

- Stabilitas Vitamin A
- Pengembangan Minyak Sawit Merah
- Stabilitas β-karoten
- Penyerapan β-karoten
- Studi keamanan β-karoten

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SUSTAIN
SHARING UNITED STATES TECHNOLOGY TO AID IN THE IMPROVEMENT OF NUTRITION

Vitamin A Fortification of P.L. 480 Vegetable Oil

CONTRIBUTING AUTHORS
Jack Bagriansky
Peter Ranum

PUBLICATION DATE
1998

PUBLICATION BY
SUSTAIN, Washington D.C.
www.sustaintech.org

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The cost of the vitamin A fortificant at 60 IU/g is $3.30/MT of oil. The total cost to fortify the 81,540 MT of non-monetized oil used in 1997 would have been $269,000 plus an estimated 5% overhead and profit. This paper provides information on the technical and economic aspects of fortifying vegetable oil with vitamin A and recommends the following:

1. Vitamin A should be added to refined vegetable oil at a level of at least 60 IU/g.
2. The level of vitamin A in fortified PL 480 vegetable oil should be specified with a range of 60 to 75 IU per gram of oil.
3. The added vitamin A should be in the form of vitamin A palmitate oil containing antioxidants.
4. Vitamin A should not be added to bulk, crude, degummed oils used in monetization programs, since subsequent refinement would destroy most of the vitamin and most monetized oil does not reach the target population.
5. The stability and uniformity of vitamin A in the fortified oil scheduled for shipment to Pakistan should be tested.
6. Additional information on how PL 480 vegetable oil is used in the field should be collected to determine whether fortification should be pursued with packaged, refined shipments of monetized oil as well as to evaluate potential impact.
7. Additional data on the effect of antioxidants on cost and vitamin A stability should be collected.

Table 2: Stability During Storage In Sealed Containers

Study	Storage Time	Storage Conditions	Vitamin A Retention
Favaro, et al. (3)	3 Months	Lab @ 23° C	99.5%
Nagy/Roche (6)		Lab @ 20-25° C	95-100%
Atwood, et al. (5)		Field @ 35° C	98%
Health Canada		Field @ 32° C	87%
Favaro, et al.	6 Months	Lab @ 23° C	99.5%
Bauerenfeid		Lab @ 23° C	91%
Nagy/Roche		Lab @ 20-25° C	90 – 95%
Favaro, et al.	9 Months	Lab @ 23° C	99%
Favaro, et al.	18 Months	Lab @ 23° C	33%

Table 3: Stability In Open Cans Under Exposure To Light And Air

Study	Duration of Oil Exposure	Conditions	Vitamin A Retention
Favaro, et al. (3)	6 Months	Open/Dark 23 C	99%
Favaro, et al.	6 Month	Open + 10 hrs light @ 23 C	99%
Favaro, et al.	3 Months (Months 6-9)	Open/Dark 23 C	76%
Favaro, et al.	3 Months (Months 6-9)	Open + 10 hrs light @ 23 C	48%
Atwood, et al. (7)	1 Month	Open in Field @ 35 C	70 – 88%
Favaro, et al.	1 Month	Extrapolated from 3 Months	92%
Favaro, et al.	1 Month	Extrapolated from 3 Months	98%

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Table 4: Stability During Boiling, Simmering Or Stewing

Study	Cooking Time	Medium	Vitamin A Retention
Favaro (3)	15 minutes	Rice	99%
Atwood (5)	15 minutes	Rice/Pulses	93%
Atwood	30 minutes	Rice, Pulses	90%
Bauerenfeind (8)	30 minutes	Corn Meal	66-75%
Gopal (9)	30 minutes	Onions, Potatoes	92%
Bauerenfeind	40 minutes	Margarine (no oil)	100%
Brooke	60 minutes	Tea (no oil)	100%
Favaro, et al.	90 minutes	Beans	88%

Table 5: Stability During Low Temperature Frying

Study	Cooking Time	Medium	Vitamin A Retention
Favaro	1 Frying	Potatoes	83%
Favaro	2 Fryings	Potatoes	81%
Favaro	3 Fryings	Potatoes	71%
Sagredos/Unilever	10 Minutes	Margarine (no oil)	59%
Favaro	4 Fryings	Potatoes	52%
Favaro	6 Fryings	Potatoes	43%
Nagy/Roche	20 minutes	Chips	90%
Sagredos/Unilever	20 Minutes	Margarine (no oil)	49%
Favaro	8 Fryings	Potatoes	27%
Sagredos/Unilever	30 Minutes	Margarine (no oil)	33%
Sagredos/Unilever	45 Minutes	Margarine (no oil)	27%

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Red Palm Oil/Minyak Sawit Merah

Hilang/ kerusakan karoten selama pengolahan → Modifikasi proses

Karakterisasi NDRPO (Neutralized-Deodorized-Red Palm Oil)

Parameter	Nilai	Pembanding 1	Pembanding 2****
Kadar asam lemak bebas (sebagai palmitat) (%)	0.16±0.01	Maks 0.1*	0.230±0.03
Kadar air (%)	0	Maks 0.1*	0
Bilangan Peroksida (meq/1000g)	6.51±0.01	0*	0.36±0.30
β-karotena (ppm)	336.34±3.20	370.1**	337.43±40.53
Dien terkonjugasi (%)	0.181±0.004	1.54±0.02***	
TBA (mg malonaldehyde eqivalen/kg)	0.02±0.01	0.932±0.038***	
Total tokoferol termasuk tokotrienol (ppm)	543.68±3.20	534.68**	

*dalam RBDPO (Basiron 2005), **dalam minyak sawit merah (Manorama *et al.* 1993),
dalam RBDPOlein (Che Man dan Tan 1999), * dalam NDRPO (Riyadi, 2009)

(Ayustaningwarno, 2010)

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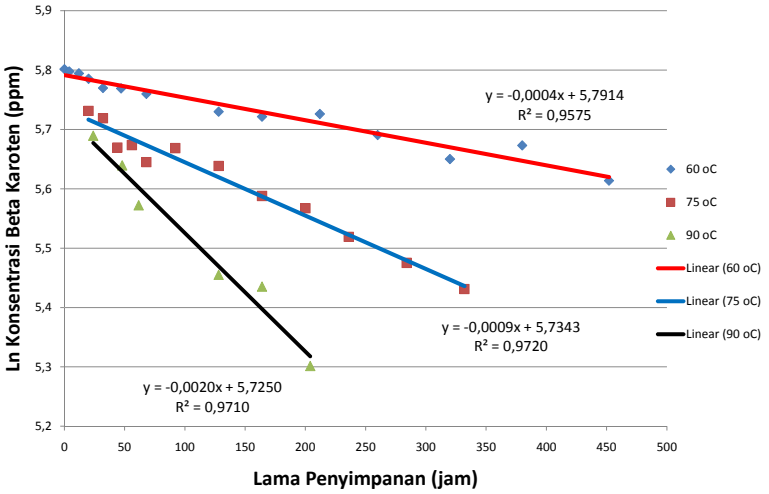
Kinetika degradasi β –karoten di MSM



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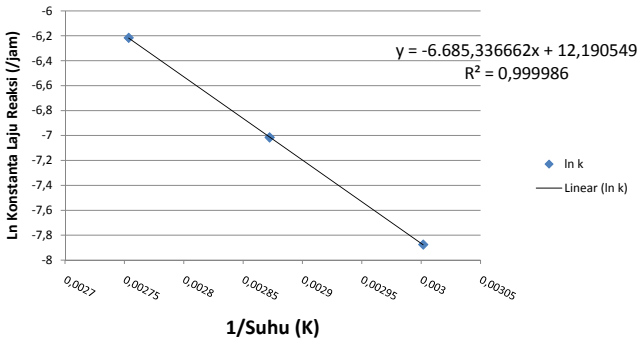
(Ayustaningwarno, 2010)

Kinetika degradasi β –karoten di MSM



k=197258.5 exp(-6685.34/T)

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(Ayustaningwarno, 2010)

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Kinetika degradasi β –karoten di MSM

- $t_s=[Ln(Q_0/Q_s)]/k$ (Ross 1998)
  - t_s= lama penyimpanan
  - Q_0= nilai mutu awal
  - Q_s= Nilai mutu akhir yang dapat diterima
  - k= konstansa kecepatan reaksi

tingginya nilai R^2 dari model yang didapatkan, maka model tersebut dapat digunakan sebagai prediksi umur simpan NDRPO.

Dengan asumsi kadar β-karotena awal adalah 500 ppm dan batas akhir adalah 400 ppm dengan kondisi penyimpanan 30 ^oC, dengan rumus Arrhenius dapat diketahui konstanta kecepatan reaksi sebesar 5.22 $x10^{-5}$ kemudian dengan rumus penurunan mutu ordo 1 dapat diketahui lama penyimpanan yaitu 4275 jam atau setara dengan 5.9 bulan.

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(Ayustaningwarno, 2010)

Potential use of red palm oil in combating vitamin A deficiency in India

B. S. Narasinga Rao

Food and Nutrition Bulletin, vol. 21, no. 2

United Nations University Press
The United Nations University
53-70 Jingumae 5-chome, Shibuya-ku, Tokyo 150-8925, Japan

TABLE 2. Carotenes in red palm oil

Carotene	Composition (%)	Actual content (ppm)
β-Carotene	56.00	308.0
α-Carotene	35.20	193.6
cis-α-Carotene	2.49	13.7
Phytoene	1.27	7.0
Lycopene	1.30	7.2
δ-Carotene	0.83	4.6
γ-Carotene	0.33	1.8
ζ-Carotene	0.69	3.8
β-Zeacarotene	0.74	4.1
cis-β-Carotene	0.68	3.7
Neurosporene	0.29	1.6
α-Zeacarotene	0.23	1.3
Phytofluene	0.68	3.7
Total		550.0

Source: Malaysian Palm Oil Promotion Council, 1998.

TABLE 3. β-Carotene content of red palm oil

Carotene	Content (μg/g)	β-Carotene equivalent
α-Carotene	145	80
β-Carotene	310	310
γ-Carotene	20	10
Lycopene	10	0
Xanthophyll	15	0
Total	500	400

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TABLE 4. Absorption (%) of carotenes from different sources in adult subjects

Carotene source	Total carotene	β-Carotene
Pure β-carotene	—	98.0
Amaranth leaves	58.1	75.7
Papaya	45.8	90.9
Carrot	35.5	81.1
Diet with mixed carotene sources	33.4	82.0
Red palm oil	80.0	90.0

EFFECT OF FOOD MATRIX AND PROCESSING ON BIOAVAILABILITY OF CAROTENOIDS

Reference: Boileau *et. al.*, 1999

Very high bioavailability

Natural or synthetic	Carotenoids – oil form
Papaya, peach, melon	Fruits
Squash, sweet potato	Tubers
Tomate juice	Processed
Carrot, pepper	Mildly cooked yellow/ orange vegetables
Tomato	Raw juice
Carrot, pepper	Raw yellow/orange vegetables
Spinach	Raw green leafy vegetables

Very low bioavailability (<10%)

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TABLE 5. Retinol equivalents (RE) of carotene from different sources

A. Based on intestinal absorption of carotene in human subjects

Carotene source	β-Carotene equivalent/μg	Absorption (%)	RE/μg
Pure β-carotene	100	98	0.50
Green leafy and other vegetables and yellow fruits	50	50	0.25
Red palm oil	80	90[a]	0.36

a. High absorption expected because red palm oil is a solution of carotene in oil.

B. Based on serum retinol response in children

Study	Vitamin A source	Amount of β-carotene/ retinol fed (μg)	Mean serum retinol increase (μg/dl)
Study 1: Daily dietary supplement of red palm oil or retinol for 2 mo	Retinol Red palm oil	600 μg/day 1,920 μg β-carotene equivalent/d	29.5 29.8
Study 2: Single massive dose of retinol compared with daily dietary supplement of red palm oil for 15 d; red palm oil serum retinol measured after 3 mo	Retinol	15,000 μg on d 1 50,000 μg β-carotene equivalent fed for 15 d (8 g red palm oil/d)	9.8 9.4

Rao, 2000

Red palm oil to combat vitamin A deficiency in developing countries

C Rukmini
Food Nutr Bull 1994; 15: 126-9

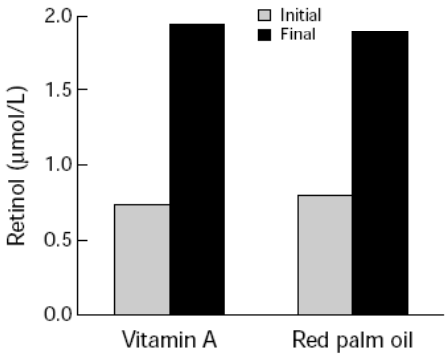

FIG. 2. Increases in serum retinol levels in schoolchildren given a dose of vitamin A or a snack containing red palm oil daily for 60 days.

Incorporation of Red Palm Oil in Edible Oil

- RPO → food had a strong, unpleasant smell and taste.
- Blend of RPO (6-12%) in cooking oil → the blend was palatable and no objectionable smell or taste of foods. RPO did impart some red color to the oil.
- The blend containing 30-70 ppm of carotene (vitamin A potency 3x that of butter).
- Potato chips retained 500-1000 µg of carotene/100 g

Rao, 2000

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Recommendation of the Nutrition Advisory Committee of the Indian Fund Research Association (now the Indian Council of Medical Research) (Rao, 2000)

- 1937 (3rd meeting) → RPO replace cod liver oil in the treatment of keratomalacia. RPO obtained from *Elaeis guineensis*.
- 4th meeting → Vitamin A content of RPO be determined at the Nutrition Research Lab and explore the suitable mix of RPO with other oils.
- 5th meeting → Studies were done on the keeping quality of mixtures. When exposed to light, the mix were bleached within 11 months, but the loss was less if it was kept in a tin container.

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Journal of Oil Palm Research (Special Issue - April 2006), p. 99-102

CHANGES OF β-CAROTENE CONTENT DURING HEATING OF RED PALM OLEIN

SEIZA AHMED ALYAS*; AMINAH ABDULAH* and NOR AINI IDRIS**

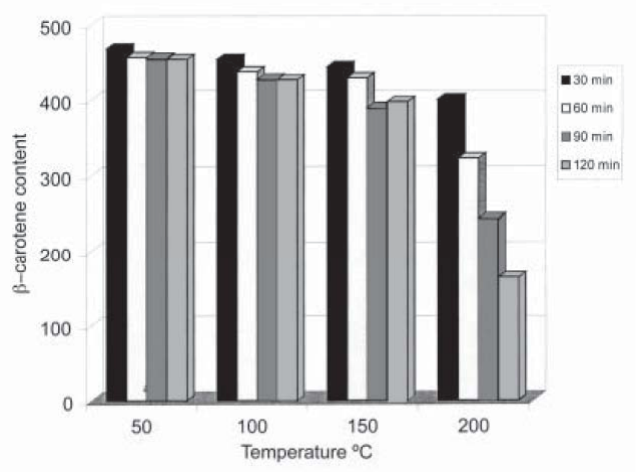

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Figure 1. β-Carotene content of heated red palm olein.

TABLE 7. Retention of total and β-carotene in cooked foods and during frying

Recipe	% retention	
	Total carotene	β-Carotene
Upma	69	70
Cake	86	88
Suji halwa	70	71
Muruku	76	77
Deep-fried food		
Before frying	100	100
1st frying	78	83
2nd frying	37	28
3rd frying	8	6

Rao, 2000

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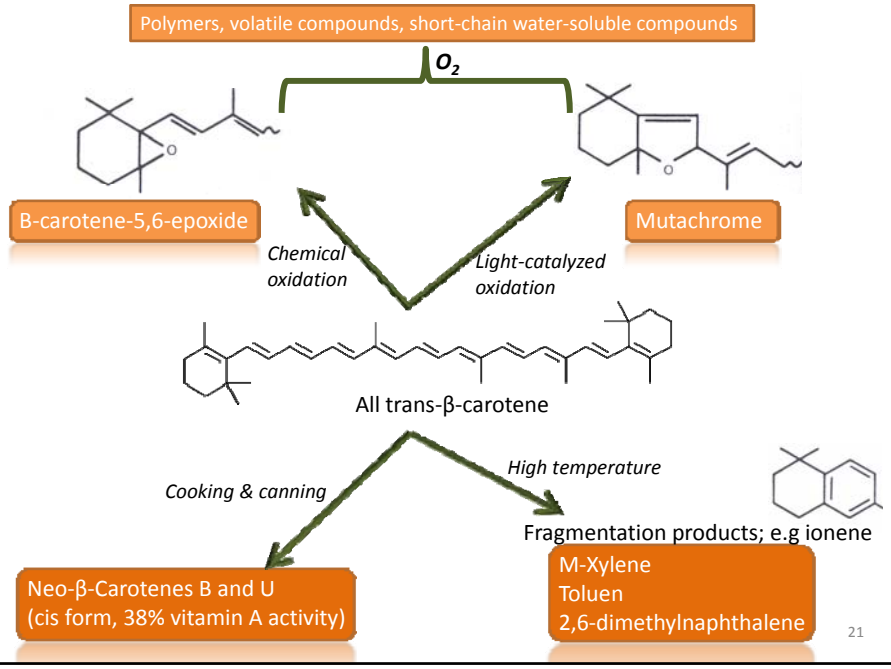
Degradation of β-carotene *(Tannembaum et al. 1985)*



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Effects of epoxycarotenoids, beta-carotene, and retinoic acid on the differentiation and viability of the leukemia cell line NB4 in vitro

Duitsman, P K : Barua, A B : Becker, B : Olson, J A

Int-J-Vitam-Nutr-Res. 1999 Sep; 69(5): 303-8

Abstract

- Three all-trans epoxides of beta-carotene (beta-Car), namely, 5,6-epoxy-beta-carotene (5,6-EC), 5,8-epoxy-beta-carotene (5,8-EC) and 5,6,5',6'-diepoxy-beta-carotene (5,6,5',6'-DEC) were synthesized by treatment of beta-carotene with 3-chloroperoxybenzoic acid, were purified chromatographically, and were characterized. The relative potencies (mean +/- S.D.) of 1 microM compounds in inducing the differentiation of NB4 cells, a cell line that contains the chromosomal transposition t(15;17) characteristic of acute promyelocytic leukemia, after 4 days of incubation were: RA: 1.35 +/- 0.16, 5,6-EC: 0.29 +/- 0.01, 5,8-EC: 0.22 +/- 0.05, 5,6,5',6'-DEC: 0.11 +/- 0.02, beta C: 0.09 +/- 0.01, and the control: 0.06 +/- 0.01. The same order of potencies existed at other concentrations tested and at other incubation times. P values for the differences between the inducing activities of successive pairs of compounds at 1 microM were: RA vs. 5,6-EC, less than 0.001; 5,6-EC vs. 5,8-EC, less than 0.01; 5,8-EC vs. 5,6,5',6'-DEC, less than 0.01; 5,6,5',6'-DEC vs. beta-Car, less than 0.10; beta-Car vs. control, less than 0.005. Similar P values were also obtained for studies at other concentrations and at other incubation times. The viable cell mass at 4 days was inversely proportional to the extent of differentiation (rs = -1.0). The inducing activities of all compounds were dose-dependent. Thus, the 5,6-monoepoxide of beta-carotene, which has not previously been studied as an inducer, showed higher activity in NB4 cell differentiation than the 5,8-monoepoxide, the 5,6,5',6'-diepoxide, or beta-carotene. Possible explanations of these observations are discussed

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Biochem. J. (1999) **339**, 359–362 (Printed in Great Britain)

Intestinal absorption of epoxy-β-carotenes by humans

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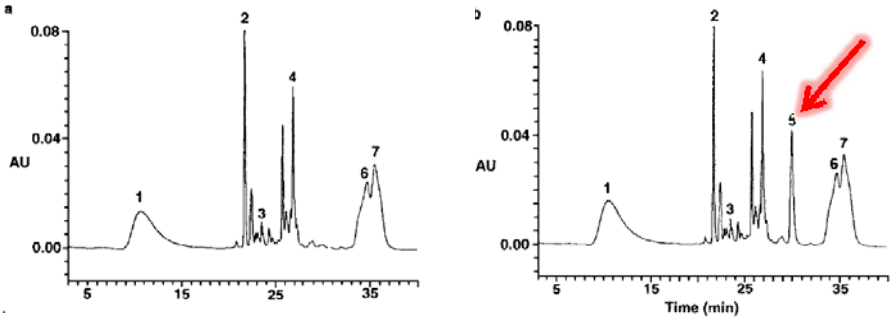

Reverse-phase gradient HPLC profiles of carotenoids in human plasma

A human volunteer was given an oral dose of 5,6-epoxy-β-carotene (9.1 μmol). Plasma was analysed for carotenoids before (**a**) and 6 h after (**b**) the oral dose. Peak identification: 1, bilirubin; 2, lutein; 3, zeaxanthin; 4, β-cryptoxanthin; 5, 5,6-epoxy-β-carotene; 6, lycopene; 7, β-carotene. The detection wavelength was 445 nm. AU, absorbance units.

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Thank You

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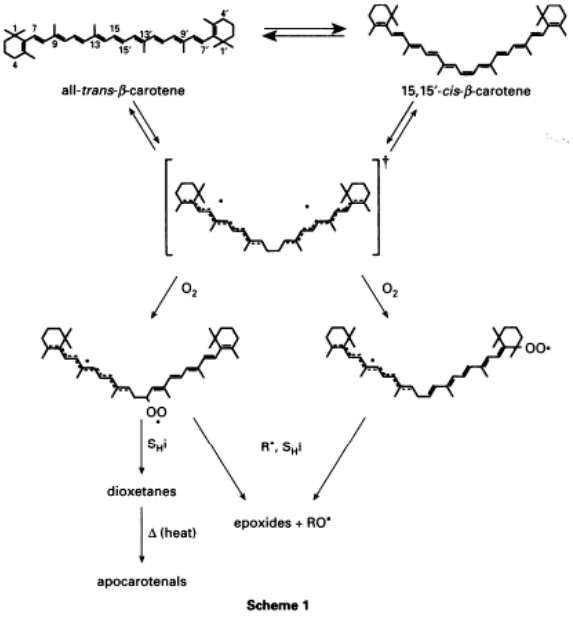

Scheme 1

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