Asia Pacific J Clin Nutr (1997) 6(2)116-118

Palm olein oil produces less lipid peroxidation products than soya bean oil

Z Zaiton[1] MBBS, PhD, Z Merican[2] PhD, BAK Khalid[3] MBBS(Homs), FRCP, PhD, JB Mohamed[4] PhD and S Baharom[2]

Departments of Physiology[1] and Medicine[3], Faculty of Medicine and Departments of Pharmacy[2] and Biomedical Sciences[4], Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

The soleus muscles of hyperthyroid rats were used to investigate the effect of palm olein oil and soya bean oil on the production of lipid peroxidation products. It was found that palm olein oil but not soya bean oil significantly decreased malonaldehyde and conjugated diene levels of the soleus muscles of hyperthyroid rats. These findings suggest that palm olein per se produces less lipid peroxidation products than soya bean oil. Such an assay method gives a composite net picture of the propensity of an oil to produce lipid peroxidation products.

Key words: Conjugated diene, malonaldehyde, lipid peroxidation, palm olein, soya bean oil, hyperthyroidism, rats, soleus muscle

Introduction

Refined deodorised and bleached palm olein oil (palm olein) and soya bean oil are used as cooking oils. Palm olein consists of 45.8% saturated fatty acids, 42.5% monounsaturated and 11.6% polyunsaturated fatty acids while soya bean oil consists of 15.1% saturated fatty acids, 23.4% monounsaturated and 61% polyunsaturated fatty acids[1,2]. It has been reported that unsaturated fatty acids increase lipid peroxidation products more than saturated fatty acids[3,4]. Besides the degree of saturation of an oil, other components of the oil can influence the formation of lipid peroxidation products. Tocopherols found in palm oil and soya bean oil[5] and tocotrienols found in palm olein[5] are antioxidants and decrease the formation of lipid peroxidation products by acting as free radical scavengers. Tocopherols and tocotrienols are believed to be the major lipid-soluble chain-breaking antioxidants found in blood plasma and membranes. Increases in lipid peroxidation products are thought to be associated with various diseases such as atherosclerosis, cancer[6,7] and myopathy[8]. In ischaemic heart disease, it is thought that lipid peroxidation may be an important event in the process of atherosclerosis[9]. Studies have shown that these free radical mediated diseases were significantly suppressed with administration of antioxidants in the form of palm oil and vitamin E [10,11]. Thus, besides knowledge of the lipid profile of an oil, knowledge of its antioxidant potential is equally important in these diseases.

In this study, the effects of oils on the production of lipid peroxidation products *in vivo* were measured by using the soleus muscle of the hyperthyroid rat. It has been reported [12] and confirmed by the authors[13] that lipid peroxidation products malonaldehyde (MDA) and conjugated diene (CD) increase in the soleus muscle of the hyperthyroid animal. Thus, the ability of an oil to decrease the level of lipid peroxidation products in the hyperthyroid soleus would indicate a desirable property in this respect.

Materials and Methods

40 male Wistar rats of similar age (8 weeks old) were divided into 4 treatment groups of 10 rats each. Each rat weighed between 250-300 grams and the groups were weight-matched. The rats were treated for a period of 8 weeks. Group 1 rats (control group) were injected intraperitoneally with alkalinised saline (pH 9-9.5) thrice weekly and were fed ground rat chow. Group 2 rats were injected intraperitoneally thrice weekly with 500 µg/kg L-thyroxine dissolved in 0.9% sodium chloride made alkaline with sodium hydroxide and adjusted to pH 9-9.5 with hydrochloric acid and were fed ground rat chow (hyperthyroid group). Group 3 rats were treated similarly to group 2 rats but, in addition, received 20% w/w of palm olein mixed with ground rat chow (hyperthyroid + palm olein group). Group 4 rats were treated similarly to group 2 rats but, in addition, received 20% w/w of soya bean oil mixed with ground rat chow (hyperthyroid + soya bean oil group).

Twenty-four hours after the final injection of the 8 week period, the rats were anaesthetized with sodium pentobarbitone injected intraperitoneally.

Preparation of homogenate and analysis of MDA and CD

The soleus muscles were removed, weighed and homogenised in phosphate buffer saline. The homogenate was centrifuged at 3000 rpm for 15 mins and the supernatant was kept at -70°C. Assays for MDA[13,14] and CD[13,15] were done within one week of killing. The MDA content of the sample was calculated as follows:

$$\text{MDA} = \frac{0.5 \times f_{\text{sample}} \times V_{\text{final}}}{F_{\text{std}} \times V_{\text{sample}}}$$

f sample: absorbance of sample
F std: absorbance of standard solution
V sample : volume of sample (ml)
V final : volume of final mixture (ml)

Statistical analysis

The data are presented as mean ± SD. Statistical significance was by unpaired t-test after a one-way analysis of variance.

Results

MDA level in the soleus muscle of the hyperthyroid group was significantly increased compared to the control group (Table 1). The MDA level in the soleus muscles of the hyperthyroid and palm olein group was significantly different from the hyperthyroid group but not significantly different from the control group

Correspondence address: Prof Dr. Zainuddin Merican, Department of Pharmacy, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda 50300 Kuala Lumpur, Malaysia.
Tel: +603-292-3066; Fax: +603-293-8205

showing that palm olein successfully brought down the MDA level to the control value. The MDA level in the soleus muscles of hyperthyroid and soya bean oil group was not significantly different from the hyperthyroid group (Table 1). This shows that consumption of palm olein produces less MDA than consumption of soya bean oil.

Table 1. Malonaldehyde levels in the soleus muscles of the four groups of rats.

Group	Malonaldehyde (nmol/mg protein)
Control (8)	3.17 ± 0.60
Hyperthyroid (8)	6.20 ± 2.60[a]
Hyperthyroid + palm olein (8)	3.06 ± 1.10[c]
Hyperthyroid + soya bean oil (8)	5.98 ± 0.94[bd]

Values indicate mean ± SD. Number of observations are given in parenthesis. Superscripts indicate significant difference from: Control [a]p<0.01, [b]p<0.0001; Hyperthyroid [c]p<0.05; Hyperthyroid + palm olein [d]p<0.0001.

The CD level in the soleus muscle of the hyperthyroid group was also significantly increased compared to the control group (Table 2). The CD level in the soleus muscles of the hyperthyroid and palm olein group was not significantly different from either the control group or the hyperthyroid group, showing that palm olein has partially decreased the CD level in the soleus muscle of the hyperthyroid group. The CD level in the soleus muscle of the hyperthyroid and soya bean group was still significantly different from the control group though at a lower level of significance. This shows that consumption of palm olein produces less CD than consumption of soya bean oil.

Table 2. Conjugated diene levels in the soleus muscles of the four groups of rats.

Group	Conjugated Diene (OD/g protein)
Control (8)	119 ± 25
Hyperthyroid (8)	228 ± 47[a]
Hyperthyroid + palm olein (8)	203 ± 71
Hyperthyroid + soya bean oil (8)	251 ± 137[b]

Values indicate mean ± SD. Number of observations are given in parenthesis. Superscripts indicate significant difference from: Control [a]p<0.0001, [b]p<0.05;

Discussion

Two products of lipid peroxidation, that is MDA and CD, were measured since a single product may not be reflective of the lipid peroxidation process. In this study, the MDA and CD contents of the soleus muscles of hyperthyroid rats were shown to be about twice their respective control values. Yet, when palm olein was added to the rat chow of hyperthyroid rats (hyperthyroid and palm olein group) the MDA and CD levels of their soleus muscles were reduced to values not significantly different from their respective control values. This shows that palm olein has antioxidant properties. When soya bean oil was added to the rat chow of hyperthyroid rats (hyperthyroid and soya bean oil group) the MDA and CD level of the soleus muscle were not raised further, but remained not significantly different from those of hyperthyroid rats. This shows that soya bean oil too has antioxidant properties; if this were not so the level of MDA and CD in the soleus would be higher compared to the level in the soleus of the hyperthyroid animal (since soya bean oil contains a high percentage of unsaturated fatty acids). Collectively, the result also shows that consumption of palm olein produces fewer lipid peroxidation products than consumption of soya bean oil. It is suggested that two factors may be responsible for the observed effect of the oils on MDA and CD. First, palm olein contains both tocopherol and tocotrienol[16] but soya bean oil contains only tocopherol[16] in quantities less than that of palm olein. Also tocotrienol has been reported to have a higher antioxidant activity than tocopherol[17]. These facts could account for the lower production of MDA and CD with palm olein consumption. However, the suggestion is made based on the assumption that the levels of tocopherol and tocotrienol in the soleus of palm olein-fed and soya bean oil-fed rats are reflective of the levels found in the oils. In future studies, the levels of tocopherol and tocotrienol in the soleus of palm olein and soya bean oil-fed rats will be measured. Another factor is that palm olein is a more saturated oil than soya bean oil and MDA and CD production would be lower with increasing saturation of an oil. Thus, the higher level of MDA and CD in the soleus of soya bean oil-fed rats compared to palm olein-fed rats could be due to its lower antioxidant activity and to its high content of unsaturated fatty acids. These are two of the factors that could contribute to the fact that rats fed palm olein produce less MDA and CD than those fed soya bean oil.

The soleus muscles from the hyperthyroid rats rather than the soleus from normal rats were used because the authors are of the opinion that it is easier to detect antioxidant activity (of the oil or any other compound) in a situation where lipid peroxidation products are raised rather than when they are at their basal level. This *in vivo* method gives a net picture of the propensity of an oil to produce lipid peroxidation products. Furthermore, it takes into account all factors inherent in the oil, known and still unknown, which may influence the production of lipid peroxidation products.

In conclusion, the study suggests that palm olein oil produces less MDA and CD than soya bean oil. As such, palm olein oil may be a better oil to use for normal cooking and also in other pathological conditions where lipid peroxidation levels are raised. In addition since repeated use of an oil exposes it to peroxidation, the less unsaturated palm olein oil would have an added advantage over soya bean oil.

Palm olein oil produces less lipid peroxidation products than soya bean oil

Z Zaiton, Z Merican, BAK Khalid, JB Mohamed and S Baharom

Asia Pacific Journal of Clinical Nutrition (1997) Volume 6, Number 2: 116-118

棕櫚油酸酯較大豆油產生較少的脂類過氧化產物

摘要

作者選用甲狀腺機能亢進大鼠的比目魚肌爲對象，研究棕櫚油酸脂和大豆油對脂類過氧化產物的影響。他們發現棕櫚油酸酯較大豆油有明顯降低甲亢大鼠比目魚肌中的丙醛和結合二烯的水平。這些發現指出了棕櫚油酸酯本身，較大豆油產生較少的脂類過氧化產物。

References

1. Chong YH. Facts about palm oil. In: New findings and facts on palm oil. ed. Malaysia: Palm Oil Research Institute of Malaysia 1988; 1-14.
2. Chong YH, Ng TKW. Effects of palm oil on cardiovascular risk. Med J M'sia 1991; 46(1): 41-50.
3. Hammer T, Wills ED. The role of lipid components of the diet in the regulation of the fatty acid composition of the rat liver endoplasmic reticulum and lipid peroxidation. Biochem J 1978; 174: 585-593.
4. D'Aquino M, Benedetti PC, Di Felice M, Gentili V, Tomassi G, Maiorino M, Ursini F. Effect of fish oil and coconut oil on antioxidant defence system and lipid peroxidation in rat liver. Free Rad Res Comms 1991; 12-13: 147-152.
5. Emken EA. Nutritional value of soybean oil compared to other fats and oils. ASA Tech Bull 1988; 4(HN-3).
6. Walton JR, Packer L. Free radical damage and protection: Relationship to cellular aging and cancer In: Vitamin E: A comprehensive treatise. ed. LJ Machlin, Marcel Dekker, Inc., New York 1980; 495-517.
7. Sinclair AJ, Barnett AH, Lunec J. Free radicals and antioxidant systems in health and disease. Br J Hosp Med 1990; 43: 334-344.
8. Hunter MIS, Mohamed JB. Plasma antioxidants and lipid peroxidation products in Duchenne muscular dystrophy. Clin Chim Acta 1986; 155: 123-132.
9. Chisolm GM. Cytotoxicity of oxidised lipoproteins. Curr Opin Lipidol 1991; 2: 311-316.
10. Sundram K, Khor HT, Ong ASH, Pathmanathan R. Effect of dietary palm oils on mammary carcinogenesis in female rats induced by 7,12-dimethylbenz antracene. Cancer Res 1989; 49: 1447-1451.
11. Wan Ngah WZ, Jarien Z, San MM, Marzuki A, Gapor AB, Shamaan NA, Khalid BAK. Effect of tocotrienols on hepatocarcinogenesis induced by 2-acetylaminofluorene in rats. Am J Clin Nutr 1991; 53(4): 1076S-1081S.
12. Asayama K, Dobashi K, Hayashibe H, Megata Y, Kato K. Lipid peroxidation and free radical scavengers in thyroid dysfunction in the rat: A possible mechanism of injury to heart and muscle in hyperthyroidism. Endocrinol 1987; 121: 2112-2118.
13. Zaiton Z, Merican Z, Khalid BAK, Mohamed JB, Baharom S. The effects of propranolol on skeletal muscle contraction, lipid peroxidation products and antioxidant activity in experimental hyperthyroidism. Gen Pharm 1993; 24(1): 195-199.
14. Ledwozyw A, Michalak J, Stepien A, Kadziolka A. the relationship between plasma triglycerides, cholesterol, total lipids and lipid peroxidation products during human atherosclerosis. Clin Chim Act 1986; 155: 275-284.
15. Buege JA, Aust SD. Microsomal lipid peroxidation. In: Meth Enzymol eds. Fleischer S, Parker L. New York: New York: Acad. Press. 1978; 52: 302-310.
16. Cottrell RC. Nutritional aspects of palm oil. Am J Clin Nutr 1991; 53: 9899-10099.
17. Serbinova E, Kagan V, Han D, Packer L. Free radical recycling and intramembrane mobility in the antioxidant properties of alpha-tocopherol and α-tocotrienol. Free Rad Biol Med 1991; 10:263-275.