Red Palm Oil for Combating Vitamin A Deficiency

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INTRODUCTION

Deficiency of vitamin A has long been recognised as a serious and preventable nutritional disease. Various intervention strategies have been implemented to combat the problem. Massive dosing of the vitamin has the advantage of immediate implementation but suffers from the disadvantage in that it applies to the isolated nutrient and requires repetitive administration. Natural food sources of vitamin A regularly included in diets offer a more viable long-term solution.

Value addition of palm oil for edible purposes results in several nutritionally rich products like edible grade red palm oil (RPO), deacidified, deodorised red palm olein, isolated carotenoids and refined, bleached and deodorised palm olein oil (RBD palm olein).

RBD palm olein can serve as a replacement for any other commonly used edible oil, but has little additional advantage over the other edible oils because it has been stripped of its carotenoids. However, its naturally rich composition of tocopherols and tocotrienols, as well as a balanced fatty acid composition, makes it more superior to other edible oils used for dietary purposes. Addition of RBD palm olein to hydrogenated vegetable oil confers no advantage, and paradoxically, decreases its beneficial properties making it a more harmful vegetable oil from the cardiovascular health angle, because of the conversion of its fatty acids from the *cis* to the *trans* type.

Use of red palm oil for edible cooking purposes could solve the problem of vitamin A deficiency in countries where this condition exists as a public health problem. However, because acceptability of the unusual coloured, viscous oil may prove to be a hurdle to its commercialisation, the production of a deacidified, deodorised palm olein by physical refining gives an excellent edible grade product with 85% of its carotenoids and tocopherols intact. There exists an urgent need to devise strategies for delivery of red palm oil in an acceptable form to vulnerable groups of the population in developing countries, who suffer from or are at risk of vitamin A deficiency.

VITAMIN A DEFIENCY

Vitamin A deficiency (VAD) has long been recognised as a public health problem among the population that exists below the poverty line, especially in developing countries that are even otherwise burdened with other related 'underlying' causes that are economical, social and political. VAD prevention and control represent a public health challenge where very real progress has been made. Although the international goal of eliminating VAD by the year 2001 may not have been realised, xerophthalmia, which is the most visible form of

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VAD, is no longer prevalent at present even in those countries where VAD has been a major public health issue. However, the VAD disorder remains a problem in most countries where it has been recognised. Seventy-three countries are now listed as having VAD based on the most recent estimates from the World Health Organisation (WHO), the United Nations Children's Fund (UNICEF) and the International Vitamin A Consultative Group (IVACG).

Three strategies that have been in use and commonly promoted to combat VAD are: supplementation with high dose vitamin A capsules/ drops, food fortification, and dietary diversification (food-based production and promotion of vitamin A and carotene rich foods). However, a broader approach that targets those vulnerable groups of the population (namely, women, adolescents, children and infants) affected at crucial periods throughout their life cycle, and using a combination of these different strategies, has been adopted by many countries and organisations to control VAD.

Carotenoids represent the most widespread group of naturally occurring pigments in nature. They are the major source of vitamin A in vegetarian diets. Yellow-orange fruits and vegetables, green leafy vegetables, and alternate sources like spirulina and dunaleilla algae have been the common sources of carotenoids used in the diets of varied populations in many parts of the world. Of the approximately 50 carotenoids with provitamin A activity, β-carotene has the greatest biological potency. In addition, they are powerful anti-oxidants and anti-carcinogens because of their ability to quench singlet oxygen.

Red palm oil, which is a extracted from the mesocarp of the oil palm (*Elaeis guineensis*) fruit, is a natural edible oil that is one of the richest natural sources of α- and β-carotene. In red palm oil, the carotenoids are naturally lipid-soluble, making them more bioavailable than from any other source. Other plant sources of carotenoids have not been able to effectively eliminate the problem of VAD due to their poor bioavailability. In this regard, red palm oil could prove to be the most efficient plant source of β-carotene, and could well be the answer to solving the problem of VAD.

Red palm oil derives its characteristic red colour from the carotenoid content, having 11 different carotenes naturally present in the oil. Retaining the carotenoids in red palm oil could provide a compelling reason to use it in public health efforts to eradicate VAD. For this reason a consolidated effort was made to evaluate this viscous, red oil, which has a strong fruity odour, for safe edibility. Even though RBD palm olein is widely used for edible purposes in the global market, and there has been no adverse effect due to its consumption. Nevertheless, the unrefined, unbleached, crude red palm fruit oil which is viscous and dark red is only known to be consumed by some African populations in Nigeria, Gambia and the Ivory Coast. Here, the fruit is also consumed after traditional processing and incorporation into several local foods.

SAFE EDIBILITY OF RED PALM OIL

There being no known published reports on the safe use of red palm oil as a dietary source of edible oil, a detailed study was undertaken to evaluate the crude red palm oil produced in India, conforming to the standards of the Central Committee for Food Standards. A multi-generation study was conducted on Wistar/NIN/inbred albino rats with one group of rats fed crude red palm oil and two control groups using refined groundnut oil and RBD palm olein at a 10% level in the diets. Reproductive parameters including percentage conception, birth weight, litter size, weanling weight, sex ratio at birth and weaning, pre-weaning mortality and number of days for delivery from introduction to mating, were recorded. Behavioural and reflexological tests were conducted on pre-weaned animals and adult animals which were subjected to weekly observations. No differences were found between the control groups and the RBD palm olein group indicating no adverse effect from RBD palm olein consumption. No teratological abnormalities were observed in any of the animals. Organ weights were also in the normal range comparable to the controls. Histopathological analysis of the organs removed after sacrifice did not reveal any abnormalities.

As a part of the safe edibility tests, mutagenicity tests were also conducted on repeatedly heated crude and refined palm olein oil, in the Ames bacterial system, using *Salmonella typhimurium* strains

TA100 and TA 98 with metabolic activation using rat liver microsomes S9 fraction. As foods are a mixture of a wide array of chemicals, they may undergo altered composition or may form mutagens during processing. Heated fats can interact with amines in foods to produce heterocyclic compounds. The results did not show any mutagenicity in the heated as well as unheated samples of both, crude and refined palm oils.

No adverse nutritional effects were noticed in red palm oil-fed animals compared to the controls of groundnut oil and RBD palm olein.

EFFECT OF PROCESSING ON β-CAROTENE CONTENT

Carotenoids are known to be unstable during heating and processing. As the objective was to use red palm oil as a cooking medium to deliver nutritionally important carotenes to vulnerable children and women lacking in vitamin A, a study was undertaken to evaluate the effect of processing on carotene retention in food products. Different cooking methods like baking, seasoning, deep-fat frying and shallow frying were used to make cakes, sweet and savoury preparations common to India. The β-carotene content of the foods products was analysed along with that of unprocessed crude palm oil. Retention of total carotenes and β-carotene contents of the different preparations ranged from 69% to 86% for total carotenes and 70% to 80% for β-carotene.

Sensory evaluation of the different recipes made with red palm oil indicated that it was well accepted by a panel of judges selected by standard procedures for sensory evaluation. The 50:50 blends of red palm oil with sunflower oil showed better acceptability than using 100% red palm oil. As these preparations were made using crude red palm oil, the strong fruity odour was slightly less well-accepted, unless masked by the other ingredients and the added flavours in the processing.

BIO-AVAILABILITY OF β-CAROTENE FROM RED PALM OIL

With the main purpose of the whole exercise being to use red palm oil as an affordable solution to eradicate VAD in vulnerable groups of the population in developing countries, it was considered imperative to assess the effect of its supplementation on the vitamin A levels in school children. Bio-availability was assessed using a modified relative dose response assay.

Twenty-four school children of 7–9 years of age were divided into two groups of six boys and six girls each. One group was given a daily supplement of *Suji halwa*, a sweet snack made with semolina and red palm oil, which supplied 2400 µg of β-carotene, while the second group was the control group who was given 600 µg of oral vitamin A palmitate. The study was over a duration of 60 days. Results of this study indicate that RBD palm olein was an efficient source of β-carotene which was found to be bioavailable in all the subjects tested. Hence, RBD palm olein can be used in supplementary feeding programs to combat VAD in target populations.

Another study was conducted on school children in Orissa, India, to assess the protective effect of red palm oil in comparison to a massive vitamin A dose in combating VAD. The study was carried out for a period of three months on 36 school children. Twelve children received a massive dose (50 000 IU) of vitamin A, another 12 received 4 g of red palm oil containing β-carotene equivalent to 25 000 IU of vitamin A in *Besan laddu*, while the remaining 12 children received 8 g of red palm oil containing β-carotene equivalent to 50 000 IU of vitamin A in *Besan laddu*. Serum vitamin A levels were measured initially, after 15 days of supplementation and at three months after termination of the supplementation. The levels were maximum at 15 days after the supplementation, and, although they fell by the end of three months, they were still significantly higher than the initial levels in all the three groups. Of the two levels of red palm oil supplements, 8 g RBD palm olein was as efficient as the massive vitamin A dose in providing protection for three months after cessation of supplementation. Red palm oil was found to be equally effective in maintaining serum retinol levels as a megadose vitamin A in those prone to VAD. In planning supplementary feeding programs, rather than through regular daily feeding, periodic feeding of red palm oil at recurring three monthly intervals may be effective in maintaining normal childhood vitamin A nutriture.

After the launch of *Carotino* a carotene-rich red palm oil, in Malaysia in 1996, a number of studies were conducted on human subjects to assess the lipid profile, vitamin A, β-carotene and tocopherol lev-

els of the oil. Feeding *Carotino* to human subjects for 15 days after a 15-day period of sunflower oil (SFO) which is rich in polyunsaturated fatty acids (PUFA), followed by a 15-day period of ghee (clarified butter) which is rich in saturated fatty acids (SFA) revealed that red palm oil did not have any detrimental effect on serum lipids, such as increased total cholesterol and LDL-cholesterol. Serum levels of vitamin A, β-carotene and α-tocopherol were also significantly increased with the consumption of *Carotino*.

The impact of red palm oil consumption on the hemoglobin status of subjects given iron supplements, along with vitamin C, was also studied. A combined deficiency of vitamin A and iron is almost always seen in developing countries. The impact of such a deficiency leads to consequences that exacerbate the problem even more, causing increased risk of mortality and morbidity along with impaired cognitive performance and physical work output. When subjects were fed iron supplements, followed by red palm oil, then followed by iron, red palm oil and vitamin C, in required daily doses, it was observed that feeding iron alone produced the lowest levels of hemoglobin, retinol and β-carotene. As expected, addition of red palm oil increased all levels, with a further increase when all three nutrients (when vitamin C was also supplied) were given.

The results from all these studies emphasise the role that red palm oil can play in improving the vitamin A status as well as overall nutritional status of populations.

CONCLUSION

Use of red palm oil for edible cooking purposes could solve the problem of vitamin A deficiency in countries where this condition exists as a public health problem. However, because acceptability of the unusual coloured, viscous oil may prove to be a hurdle to its commercialisation, the production of adeacidified, deodorised palm olein by physical refining gives an excellent edible grade product with 85% of its carotenoids and tocopherols intact.

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