



Carotino Enriched Biscuit

developed and scientifically evaluated by the
South African Medical Research Council as part of
the solution to address micronutrient deficiencies in

vulnerable groups



Adequate nutrition is a basic human right and a prerequisite for the attainment of an individual's full physical and intellectual potential. Undernutrition does not only affect growth and development of children, but may also contribute to ill health and functional impairment in every stage of the life cycle. Improving the nutritional status of the undernourished through research is thus ethical, imperative and a sound economic investment.





The Carotino biscuit

What is a Carotino biscuit?

The Carotino biscuit was specifically developed by researchers of the Nutritional Intervention Research Unit (NIRU) of the South African Medical Research Council (MRC) for people who are at risk of 'hidden hunger'. This biscuit is rich in β -carotene (the precursor of vitamin A in the body), vitamin E and iron.

'Hidden hunger' or micronutrient deficiencies

The term 'hidden hunger' refers to an inadequate intake of micronutrients (minerals, vitamins and trace elements) because the effects of micronutrient deficiencies, although far-reaching and detrimental, cannot easily be seen.

The consequences of micronutrient deficiencies

Vitamin A deficiency

- Vitamin A deficiency mostly affects children. Worldwide 250 million children are at risk.

- Vitamin A deficiency causes night blindness and can, in severe cases, cause permanent blindness.
- Vitamin A deficiency can contribute to poor growth in young children.
- Vitamin A deficiency can impair the immune system and thus lower the body's resistance to infections, which will result in high rates of sickness and may even lead to death.
- Vitamin A is essential for normal fetal development during pregnancy, so a deficiency will affect the fetus adversely.
- If lactating mothers have a poor vitamin A status, their breastfed infants are likely to be subclinically vitamin A deficient by 6 months of age.



Rural area in KwaZulu-Natal where research was undertaken

Iron deficiency

Iron deficiency mostly affects children and women of child-bearing age. Iron deficiency leads to anaemia which means that there are not enough healthy red blood cells to carry oxygen to the different parts of the body.

- Anaemia in infants and children can lead to
 - retarded growth
 - reduced resistance to infections
 - slow development of learning abilities and
 - tiredness and inability to concentrate, resulting in poor school performance.
- In pregnant women anaemia may lead to
 - low birth weight of babies and
 - increased risk of death of babies at birth.

Development of the original fortified biscuit to address 'hidden hunger'

A study by researchers of the NIRU found that few of the schoolchildren who received five cooked meals per week, as part of a school feeding scheme, were underweight, but their vitamin A and iron status was low.¹ They were thus suffering from 'hidden hunger'. In 1995 the South African Vitamin A Consultative Group (SAVACG) study on children 6 months to 6 years of age showed that one in three South African children had a marginal vitamin A status and one in 10 children was iron depleted or iron deficient.² Research undertaken by the NIRU in KwaZulu-Natal, South Africa, showed that approximately 45% of the children had subclinical vitamin A deficiency and about 24% were anaemic.³ Scientific information therefore clearly indicated that there was an urgent need to find a way to address 'hidden hunger' in South Africa. It was realised that the fortification of an appropriate food vehicle could be a solution, but research was necessary to prove this.

Beta-carotene was chosen as the food fortificant to address the

vitamin A deficiency, because β -carotene is considered to be non-toxic in contrast to preformed vitamin A which could potentially lead to toxicity when consumed in large amounts.

A biscuit was chosen as the carrier for the β -carotene and iron because:

- research in the study population showed that children were already purchasing a low-cost shortbread type of biscuit at the local shops and that it was popular
- it would be regarded as a snack, and therefore it was unlikely to replace a meal at home which may happen when school feeding programmes are introduced
- it is easy to distribute
- it needs no preparation
- it has a long shelf-life.

A biscuit fortified with β -carotene, iron and iodine was developed and tested over a period of a year in schoolchildren.¹ The study consisted of a control group (non-fortified biscuit) and an experimental group (fortified biscuit). In Figure 1 results of the effect of the consumption of three fortified biscuits, five days per week, on the prevalence of vitamin A and iron deficiency, are shown. The fortified biscuits supplied approximately 50% of the Recommended Dietary Allowance⁴ for vitamin A (as β -carotene) and iron. A cold drink fortified with vitamin C was served with the biscuit to improve iron absorption. Not only did the study show an improvement in vitamin A and iron status, it also demonstrated:

- a decrease in the prevalence of iodine deficiency from 97.5% to 30.2% within 6 months
- improvement in cognitive tests which measured short-term memory and attention span
- a reduction in the number of school days missed as a result of respiratory and diarrhoea-related illnesses.

This study proved that fortification of a biscuit is an acceptable, effective and practical way to combat specific micronutrient deficiencies.

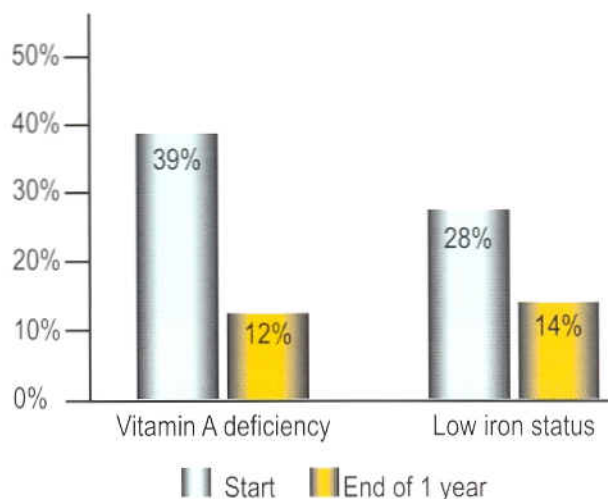


Figure 1 Prevalence of vitamin A deficiency and low iron status at the start of the study and after 1 year of consuming three fortified biscuits, five days per week

Development of the Carotino biscuit

After successful completion of the study with the original biscuit, fortified with β -carotene and iron and which contained hydrogenated baking fat routinely used in the baking industry, the NIRU became aware of Carotino baking fat. Carotino baking fat offers certain advantages above industrially hydrogenated fat. This baking fat is made from red palm oil from Malaysia. In its strive to always improve on its research efforts, the NIRU decided to investigate the possibilities of using this fat in the fortified biscuit because:

- Carotino baking fat, with its yellow-red colour, is a natural source of carotenoids including β -carotene. In the fortification process



Cross-section of palm fruit

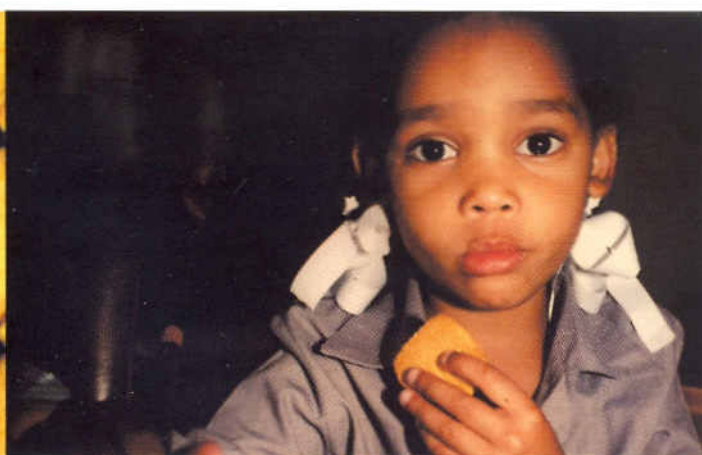
synthetic β -carotene needs to be added as a separate ingredient to the biscuit mixture and an even distribution of the vitamin in the biscuit dough cannot be guaranteed. However, when Carotino baking fat is used, it is easier to accomplish an even distribution of the vitamin in the dough, because β -carotene is a natural component of the baking fat.

and lower high density lipoprotein levels, which could lead to the development of coronary heart disease.⁷ There are also indications that *trans* fatty acids may lead to retarded growth.⁸

Composition of Carotino baking fat

Red palm oil is produced in Malaysia from the yellow flesh surrounding the seed (the palm kernel) of the fruit of the oil palm trees. Red palm oil is refined by a special patented refining process which retains 85% of the carotenoids present in the oil. The more liquid part (olein) of the oil is separated from the more solid (stearin), higher melting point, part of the oil in the fractionation process. This process can be adapted to give a particular fat which will meet the needs of the food industry. A special patented process is used to produce Carotino fat. Carotino baking fat contains approximately the same percentage of palmitic and oleic acids.

- Carotino baking fat is rich in the vitamin E antioxidants, tocopherols and tocotrienols. Vitamin E serves as a natural antioxidant to prevent polyunsaturated fatty acids from easy oxidation. The vitamin E could therefore increase the shelf-life of the products in which it is used, without synthetic antioxidants having to be added. In addition, vitamin E acts as a tissue antioxidant and may protect the body from the development of degenerative diseases such as cancer and cardiovascular disease.^{5,6}
- Carotino baking fat does not contain *trans* fatty acids that are present in large quantities in hydrogenated baking fats generally used in the baking industry. Studies have shown that *trans* fatty acids can increase plasma cholesterol levels



Carotino biscuit and carotino baking fat

Composition of Carotino baking fat

Fatty acids	Mean
Myristic (C14:0).....	0.8%
Palmitic (C16:0).....	43.6%
Stearic (C18:0).....	5.1%
Oleic (C18:1).....	40.6%
Linoleic (C18:2).....	9.9%

Antioxidant content* per 100 g	
β-carotene RE	3000
Other carotenoids RE	1833
Alpha-Tocopherols α TE	15
Tocotrienols α TE.....	10.5

* Based on information supplied by Carotino SDN BHD, Malaysia

Research with the Carotino biscuit

The NIRU compared the effect of the Carotino biscuit with the original biscuit, containing synthetic β-carotene and hydrogenated fat, in 400 schoolchildren in the age group 5 to 11 years. The study also included a control group. As with the original biscuit, the Carotino biscuit was also fortified with iron and the children received the biscuits for three months.⁹ Results showed that both the Carotino biscuit and the biscuit fortified with synthetic β-carotene increased serum vitamin A levels significantly. There was no significant difference between the effect of the two biscuits on the vitamin A levels of the children.

The study with the Carotino biscuit clearly showed that:

"A biscuit with red palm oil as a source of β-carotene is as effective as a biscuit with synthetic β-carotene in improving the vitamin A status of primary schoolchildren. The additional qualities of red palm oil (i.e. no *trans* fatty

acids; rich source of antioxidants) make it an excellent alternative fortificant for addressing vitamin A deficiency." 9

Advantages of using the Carotino biscuit to address micronutrient deficiencies

- The *Carotino biscuit* is the only fortified biscuit which carries the MRC logo and this means that:
 - * this biscuit, and the original biscuit, are the only South African biscuits on which scientific research has been done
 - * the health claims made about the *Carotino biscuit* are based on sound scientific research
 - * only accredited bakers are allowed to bake the product and quality control is thus assured.
- The *Carotino biscuit* is a good source of β -carotene (the precursor of vitamin A in the body), vitamin E and iron. To enhance the absorption of iron it is recommended that the biscuit is served with a good source of vitamin C.
- The β -carotene in the *Carotino biscuit* is not toxic. In contrast with preformed vitamin A (retinol), which occurs only in food from animal origin, the conversion of β -carotene to vitamin A is regulated according to the needs of the body. This eliminates the risk of toxicity which is not the case when preformed vitamin A is consumed.
- Because of its important content of specific micronutrients, the *Carotino biscuit* will make an important contribution to the intake of these nutrients in vulnerable groups such as children, pregnant women, nursing mothers and their infants, and adults working long hours under strenuous conditions.
- The *Carotino biscuit* also has great potential to be a carrier for other micronutrients such as zinc, copper, iodine and the B-complex vitamins.
- Because it is a snack, the biscuit does not interfere with normal eating patterns of children.
- The β -carotene is present in a natural form in the baking fat, thus ensuring that it is evenly distributed in the dough and in the biscuits.
- No harmful *trans* fatty acids are present in the biscuits.
- Carotenoids and vitamin E, which are antioxidants, occur naturally in the baking fat, therefore it is not necessary to add synthetic antioxidants to the biscuit.
- *Carotino biscuits* have a shelf-life of over 6 months which makes them ideally suited for distribution in remote rural areas.
- It is more economical to bake the *Carotino biscuit* than a biscuit fortified with synthetic β -carotene and in which hydrogenated baking fat has been used.
- At an affordable price the *Carotino biscuit* is an ideal vehicle for addressing micronutrient deficiencies in developing countries.
- It is easy to manage and monitor the distribution of the biscuit in feeding schemes.





Nutritional composition of the Carotino biscuit

Composition	Per 45 g (3-4 biscuits)*	Per 100 g (7-8 biscuits)*
Energy (kJ)	844	1875
Protein (g)	3.6	8.1
Carbohydrate (g)	32.1	71.3
Fat (g)	7.2	16.1
Fibre (g)	1	2.3
Sodium (mg)	70	156
β -carotene (RE)	216	483
Other carotenoids (RE)	132	295
Tocopherol (α TE)	1.08	2.42
Tocotrienol (α TE)	0.76	1.69
Iron (mg)	5	11

* Approximate weight of a biscuit is 15 gram, but weight may vary slightly

Technical information

Ingredients of the Carotino biscuit: Wheaten flour, sugar, Carotino fat (vegetable origin), water, ammonium bicarbonate, salt, vanilla essence, ferrous fumarate.



Packet of Carotino biscuits with the logo of the Medical Research Council to indicate that the effect of these biscuits on health has been scientifically proven.



Contribution of the Carotino biscuit to the Recommended Dietary Allowance for vitamin A, vitamin E and iron intake of different age groups and in pregnancy or lactation

Groups	% RDA* per 45 g (3-4 biscuits)		
	Vitamin A	Vitamin E	Iron
Children 4-6 yrs*	70	25	50
Children 7-10 yrs*	50	25	50
Adults & Children > 10 yrs*	44	18	36
Pregnancy/lactation*	29	12	28

*RDA - Recommended Dietary Allowance⁴

*Labelling regulations

Recognition of the Carotino biscuit¹⁰

The Carotino biscuit was the winner of the second round of the Haarmann & Reimer/Food Review New Product Competition. The potential nutritional contribution it could make in addressing micronutrient deficiencies, and the innovative idea of introducing Carotino baking fat and all its other benefits to biscuit-making, were given as the reasons for this recognition.

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For further information contact:



Nutritional Intervention Research Unit

Medical Research Council, P O Box 19070, Tygerberg 7505, South Africa

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