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FORTIFICATION OF PERSIAN-TYPE BREAD WITH VITAMIN A

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ABSTRACT

This study was undertaken to investigate the practicality of fortifying sangak, a Persian-type sheet bread, with vitamin A. The average per capita bread consumption in Iran is between 300 to 500 g daily, providing 80 to 90% of the total caloric intake of people in many parts of the country who, the survey determined, have a deficiency of vitamin A in their diets. Two chemical forms of the vitamin were used in baking four batches of bread—two with palmitate and two with acetate. With 48.42 mg of palmitate or 49.02 mg of acetate added to each 100 g of flour enough vitamin A remained after baking to provide 50 to 70% of the recommended daily dietary allowances for adult males, assuming an average consumption of bread. About 70% of the vitamin added to the dough in the yeast was recovered after the bread had been baked 2-3 min "Iranian fashion" on pebbles heated to about 204° C.

People in many parts of Iran have a deficiency of vitamin A in their diets. Night blindness is prevalent in the south, west, and northwest, particularly among those living in the rural areas (1,2). One of its causes is a lack of vitamin A in sufficient quantity. In the regions where the survey revealed an insufficiency of this vitamin, the people consume little or no milk or other dairy products. Additionally, fresh fruits and vegetables are a part of their diet only when these are in season (3).

In normal diets the usual vehicles for the fat-soluble vitamins are milk, butter, and margarine. These effectively provide the nutrients in a culture where butter is used at every meal with bread and vegetables, and consumption of milk and other dairy products is high. In Iran in the lower socioeconomic category of both the urban and rural populations milk and butter are not consumed in adequate amounts due to the lack of availability and high cost. In fact, fat intake is dependent upon the person's income. They receive between 80% and 90% of total caloric intake from bread; therefore, its enrichment with vitamin A appears to be a practical solution to overcoming the deficiency.

An attempt to incorporate vitamin A in bread has been reported. Borenstein (4) added vitamin A palmitate to white flour and recovered 87% after the bread

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had been baked. A unique difference in Iran, however, is the form of bread and its flat surface which permits greater exposure to heat. The most popular bread, sangak, is a sheet 0.5-1.0 cm thick, 80 cm long, and 30 cm wide. It is baked on pebbles for 3-4 min at a temperature near 210° C.

This present study was undertaken to explore further the possibility of using bread as a vehicle for vitamin A supplementation and to test the practicality of combining the correct amount of the vitamin with yeast into premeasured tablets and packages on a ready-mix mass production basis.

MATERIALS AND METHODS

Two chemical forms of vitamin A—palmitate and acetate—were used. Table I shows specifications for each. Retinal activity in the commercial samples was determined by the Carr-Price method (5). Assuming that the target population consumed an average 300-500 g of bread daily, vitamin A can be added so that the amount would be 0.30 mg per 100 g of bread (1000 IU/100 g). This would provide about 50% of the recommended dietary allowances as established by the Food and Nutrition Board of the National Research Council (6).

To obtain an accurate measurement of the stability of vitamin A in bread, four batches were baked, two with palmitate and two with acetate. The amounts of vitamin A added in these studies were increased 15 times (48.42 mg of palmitate or 49.02 mg of acetate) to facilitate the measurement of the per cent recovery. In practice, the above-mentioned 1000 IU per 100 g of bread would be used. The

TABLE I
Form and Quantity of Vitamin A Added to Bread

Chemical form	Particle size mesh	mg Retinal Activity per g[a]	Added to 100 g Flour mg
Palmitate	30–90	151.5	48.42
Acetate	30–100	138.3	49.02

[a]Retinal activity in each g of both forms of vitamin A as determined chemically before addition to the flour.

TABLE II
Stability and Distribution of Vitamin A in Bread

Bake Number		Moisture %	mg Retinal added to 100-g bread	mg Retinal retained in 100-g bread	Stability
Palmitate	1	33.5 ± 3.1	5.26	3.58 ± 0.21	68.00%
	2	32.9 ± 2.3	5.26	3.81 ± 0.11	
Acetate	1	35.0 ± 1.9	4.77	3.57 ± 0.18	74.00%
	2	34.9 ± 2.4	4.77	3.31 ± 0.15	

vitamin was mixed with the amount of yeast necessary to leaven 70 kg of flour (48.42 mg palmitate or 49.02 mg acetate to each 100 g flour and 500 mg yeast) then the yeast was mixed into the flour. Determined chemically before addition to the flour, retinal activity per g of palmitate was 151.5 mg and 138.3 mg per g of acetate. The flour was mixed with water and sangak prepared for the oven. The bread was baked in a regular bakery; each sheet at about 204° C for 2–3 min on pebbles covering the floor of the oven. Throughout the baking period, samples were obtained from 1 of every 10 to 15 sheets and taken to the laboratory immediately.

The amount of moisture was determined. Samples having a 40% content were weighed and cut with a pair of sharp scissors into particles passable through a No. 8-mesh screen. Particles were saponified and vitamin A and carotenoids extracted using pure *n*-hexane. No carotenoids were found in the extract as indicated by column chromatography. Vitamin A was extracted by pure ethyl and determined colormetrically, according to the Carr-Price procedure (5). The only modification was use of the fresh samples of bread.

RESULTS AND DISCUSSION

Since each 100 g of flour yields approximately 140 g of sangak, 5.26 mg retinal in palmitate form or 4.77 mg in acetate form had been added for each 100 g of bread. The two palmitate batches retained 3.58 ± 0.21 mg and 3.81 ± 0.11 mg retinal, and the two acetate batches 3.57 ± 0.18 mg and 3.31 ± 0.15 mg (Table II). The batch with highest retinal content also was the bread with the least moisture (32.9 ± 2.3). Vitamin A acetate showed the greater stability, however (74%).

In our initial attempt to enrich bread with vitamin A the same Carr-Price measurement procedure had been used as in this study except that baked samples were dried in a vacuum at 40° C, the amount of the vitamin was then determined. We recovered about 50%. Further study revealed a loss of more than 20% in the vacuum-drying process.

Table III shows the per cent recovery of vitamin A in the initial study as compared with 12, 6, and 0 hr vacuum-drying time in trials 1, 2, and 3, and results of the present study. About 70% of the vitamin added to the dough in the yeast was recovered after baking with no vacuum drying. The third trial with no vacuum drying showed a recovery range of 61 to 82% and the present study a range of 68 to 74%. These results compare favorably with those reported by

TABLE III
Recovery of Vitamin A

	Drying time in vacuum	Recovery (range)[a] %
First attempt	20 hr	37–71
Trial 1	12 hr	29–48
Trial 2	6 hr	49–71
Trial 3	0 hr	61–82
Present study	0 hr	68–74

[a]Range of per cent recovery among 10 samples in each bake.

Borenstein (4). This amount in the baked bread indicates that it can be used as a vehicle to supplement the intake of vitamin A. When the usual and customary 300–500 g of bread are consumed daily, an adequate intake of this nutrient can be provided.

The method of enrichment—yeast tablets and packages—would eliminate any operational mistakes on the part of the baker, since each would contain an adequate amount of the nutrient for the particular batch of bread baked. The procedure would alleviate most control and measurement problems in a network of decentralized bakeries. The baker would leaven his bread and enrich it at the same time. The actual mixing of vitamin A with the yeast on a mass production basis could be accomplished at the yeast producing plant. As there is only one in Iran, adequate check and control could be exercised so that the correct amount of the nutrient would be added.

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