



High phytate content of rural Iranian bread: a possible cause of human zinc deficiency^{1,2}

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Within the past decade, zinc deficiency has been encountered in humans in Iran (1) and Egypt (2). It is manifested in its fully developed form as a syndrome of hypogonadism and arrested growth, both being a consequence of the lack of pubertal development. Proof that zinc deficiency is responsible has been obtained by administration of zinc, together with a balanced diet, to affected youths. Maturation of the gonads and renewed somatic growth followed within a few months (3, 4). Although at first it was believed that only males were susceptible, the syndrome recently was found to affect females (Ronaghy and Halsted, unpublished observations). The incidence among 19-year-old conscripts in rural Iran was estimated as nearly 3% (5).

Zinc intakes of affected populations exceeded by a substantial margin the requirements of man, which are estimated to be 12 to 15 mg daily (6, 7). Therefore, some cause other than low zinc intake must be responsible for the development of the deficiency. It was observed, moreover, that all who were afflicted lived in villages (5). Previously, the village environment in Iran had been found to affect zinc nutrition unfavorably in childhood and pregnancy (8, 9). A recent comparison (7) of the village dietary with that of the corresponding socioeconomic group living in Shiraz, the major city of the region, showed the two to be similar. Flat breads prepared from wheaten meal of high extraction provided at least one-half the caloric intake in both.

City and village diets differ, however, in type of bread consumed. Bread eaten in

the village (tanok or lavosh) is made in the home without addition of leaven or opportunity for fermentation by indigenous yeasts. The meal is mixed into a stiff dough, rolled into thin sheets, then baked briefly on heated sheet metal. By contrast, bread in Shiraz is made in commercial bakeries. Leaven is added in the form of starter from a previous batch and 2 to 4 hr are allowed for fermentation. The doughs are then flattened and baked on the roof of a brick oven (bazari) or on pebbles (sangak) for about 2 min. The whole meals used for tanok and sangak contain nearly all of the phytic acid of the wheat, that for bazari somewhat less. As none of the operations of village breadmaking destroys appreciable amounts of phytate, the village bread must retain nearly all that was in the grain. On the other hand, the fermentation carried out by the bakers in the city should bring about considerable destruction of phytate by action of phytase in yeast.

Materials and methods

The phytic acid concentrations of the three types of bread have been examined. Samples of tanok were obtained from 17 villages within 50 km of Shiraz. Three to ten samples were obtained from each during the months of November through

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March. Bazari and sangak were purchased from bakeries in Shiraz from the beginning of September through March. The breads were air-dried at about 40 C, then crushed in a mortar, and stored in plastic containers. Phytic acid concentrations were measured by precipitation as ferric phytate in 0.6% HCl, using the method of Earley and DeTurk (10) as modified by Oberleas (11), and determining the phosphate concentrations in the washed precipitate.

Results and discussion

The phytate concentrations of the three types of bread are shown in Table 1. It may be seen that the village bread, tanok, contains more than twice as much phytate as bazari, the more widely consumed of the two city breads, and one-half again as much as sangak. The effect of leaven and fermentation is clearly shown by the difference between the latter and tanok, since the phytate concentrations of the meals from which they are prepared are similar.

Lower concentrations of phytate in bazari and sangak were found in September and October when temperatures in Shiraz ranged between 22 and 32 C, and the highest concentrations were found in the winter months. The difference is attributed to the decreased activity of yeast fermentation as the temperatures in the bakeries fell during cold weather. A few samples of tanok had phytate concentrations that were well below those of the remainder. It was not possible to identify these breadmakers, but it is probable that they allowed fermentation to occur. Village whole meals are heavily contaminated with microorganisms and fermentation occurs spontaneously in a short time. This type of fermentation offers one method by which phytate intakes of villagers may be lowered.

By consuming large quantities of bread of high phytate content, the Iranian villager ingests substantial amounts of phytate day after day, far more than is taken in by residents of the city. Phytate forms complexes with calcium, iron, and zinc that are poorly absorbed from the gastrointestinal tract (12-14). Zinc is especially susceptible to the presence of high concentrations of phytate because of a zinc-calcium-phytate interaction (15).

A high phytate intake, therefore, could ex-

TABLE 1
Phytate concentration of Iranian flat breads

Type	Source	No.	Phytate, mg/100 g dry bread	
			Mean	SD
Bazari	City	36	301	96.9
Sangak	City	30	401	116.5
Tanok (lavosh)	Village	96	630	140.0

plain the development of zinc deficiency in the Iranian villager despite his seemingly adequate zinc intake, whereas the city dweller, who consumes less phytate, would escape. It may explain also the prevalence of rickets among village children in a region of abundant sunshine, and the high incidence of iron deficiency anemia. Consumption of unleavened breads made from high extraction meals by primitive methods is widespread among rural populations of developing countries of the Middle East. It undoubtedly constitutes a major public health nutrition problem that deserves more attention than it has received.

Summary

Phytate concentrations of the unleavened flat bread (tanok or lavosh) prepared from high extraction wheaten meal in Iranian villages are much greater than those of leavened flat breads (bazari or sangak) made in commercial bakeries in cities of the same region. As a result, the phytate intake of the rural population considerably exceeds that of the urban population. Excessive intakes of phytate may explain the occurrence of overt zinc deficiency among villagers and its absence in the cities. ❏

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