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Nitrate and nitrite contents in *ogi* and the changes occurring during storage

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Nitrate and nitrite, which are known to be toxic, were determined in market samples of *ogi*, a fermented maize product in Nigeria. The nitrate and nitrite contents varied from 4.2 to 100.3 ppm (mean = 39.9 ± 23.2 ppm) and from 0.027 to 0.062 ppm (mean = 0.03 ± 0.008 ppm), respectively. On storage under water at room temperature over a period of 8 days, nitrate decreased by about 80% while the nitrite accumulated by about 200% of their initial levels. Nitrate and nitrite levels in *ogi* were below the current acceptable daily intake (ADI), but their toxicity implications are briefly discussed.

INTRODUCTION

There is an increased awareness of the relationship of the nitrate and nitrite content of food and water supplies to methemoglobinemia found in children and the formation of carcinogenic nitrosamines (Walker, 1990; Levallois & Phaneuf, 1994). Nitrosamines are produced by the acid catalysed reaction of nitrite with certain nitrogen compounds. Infant methemoglobinemia has been shown to be a result of too much nitrate in the food and drinking water. Darvas (1966) and Bradberry *et al.* (1994) reported that the nitrate contents of water supplies which induced methemoglobinemia and gastric cancer were significantly higher than normal. The nitrate content of any food is in direct proportion to the potential amount of the more toxic nitrite that may be present. Nitrite is shown to arise from microbiological reduction of nitrate in foods or water when such foods are stored at room temperature or under refrigeration (not frozen) (Jones & Griffith, 1965). Post-harvest storage of vegetables, for example, favours high nitrite accumulation and a decrease in nitrate content (Phillips, 1968; Payne, 1973).

Maize is processed in Nigeria in a variety of ways, one of which is into *ogi*. When steeped in water, milled, sieved and fermented, maize yields a mash which when boiled forms a gruel which is consumed (Akingbala *et al.*, 1981). *Ogi*, usually prepared in bulk and stored over a period, has become the cheapest weaning food and, among the peasants, the only supplement to mothers milk. The utilization of *ogi* after long periods of storage for babies therefore may pose a health problem since nitrites may accumulate during storage. In view of this, it was felt desirable to assess the levels of nitrate and nitrite present in *ogi* since infants under 3 months of age are known to be more susceptible to their toxic effects (Betke *et al.*, 1956).

MATERIALS AND METHODS

A total of 40 market samples of *ogi* weighing 50 g, taken from different areas in Ibadan city in Nigeria, were analysed for their nitrate and nitrite contents. The samples were then pooled and stored under water at room temperature (26–27°C) as done locally.The nitrate and nitrite contents were assayed on 8 consecutive days.

Extraction of samples

Twenty grammes of each sample was measured and mixed with 80 ml of double-distilled water. About 10 mg of mercuric chloride was added as deproteinizer and allowed to stand for 15 min. The mixture was shaken vigorously for about 5 min until a fine slurry was formed. The slurry was then filtered through Whatman No. 32 filter paper and a clear solution of the sample extract obtained.

Estimation of nitrate and nitrite

Nitrate and nitrite contents in the sample extracts were determined colorimetrically and by extrapolation from standard curves of nitrate- and nitrite-N as previously reported (Ezeagu & Fafunso, 1995).

RESULTS AND DISCUSION

The nitrate content varied from 4.2 to 100.3 ppm (mean = 39.98 ± 23.29 ppm) while the nitrite level ranged

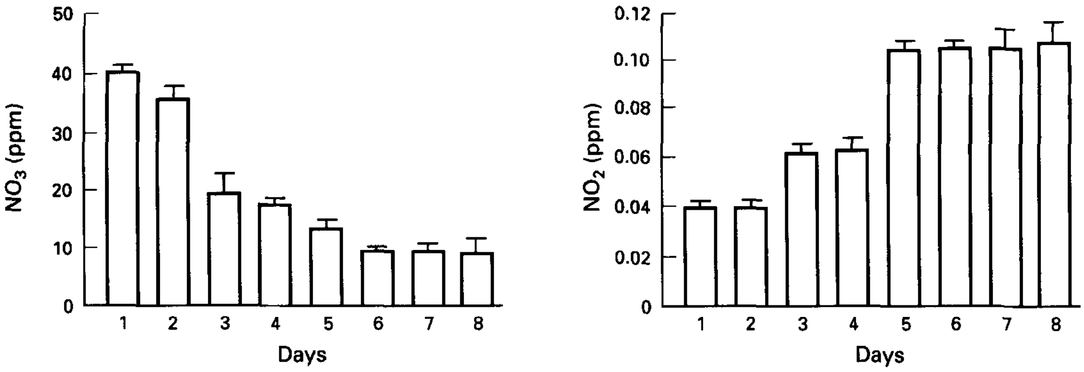

Fig. 1. The effect of storage on nitrate and nitrite content (in ppm).

from 0.027 to 0.062 ppm (mean $= 0.03 \pm 0.008$ ppm). These values are low when compared to those reported for most common vegetables and vegetable products (White, 1975; Ezeagu & Fafunso, 1995) and the 500 ppm limit recommended by WHO/FAO (WHO, 1973). Maize grains usually contain low levels of nitrate/nitrite (62.0/3.0 ppm) but the levels may vary on processing or cooking (Walker, 1990). The wide variations of nitrate levels(4.2–100.3 ppm) in the samples is most probably due to maize strains, growing conditions and the use of nitrogen fertilizers (Viets & Hageman, 1971; Miedzobrodzka *et al.*, 1992). Also the degree of freshness of the samples and processing methods may correlate to the contents of these compounds in the market samples. The length of time the samples spend in the market is not easily detectable. The effect of storage is displayed graphically in Fig. 1. Nitrite content increased from 0.036 to 0.105 ppm during the first 5 days, i.e. about 200% its initial level. Conversely, the concentration of nitrate decreased by about 80% by the eighth day. This may be attributed to the conversion of nitrate and other nitrogenous compounds to nitrite during storage by bacteria containing nitrate reductase enzyme (Payne, 1973; Sasaki & Matano, 1980). Aspects of microbial activities and biochemical changes during the fermentation of *ogi* has been reported (Akinrele, 1970; Adegoke & Babalola, 1988).

A 5 kg baby would normally be fed about 0.1 kg *ogi* per day. This would mean a maximum daily intake of 10.0 mg nitrate and 0.0062 mg nitrite. This is still within the limits of the WHO/FAO (WHO, 1974) ADI of 3.7 mg (5 mg $NaNO_3$)/kg body weight and 0.067 mg (0.1 mg $NaNO_2$)/kg body weight allocated to nitrate and nitrite, respectively. Therefore from the standpoint of nitrite toxicity, based on its level before ingestion, *ogi* presents no hazard. But since nitrates may be considered as the index to the amount of nitrite which may be formed, it is clearly inadvisable to use *ogi* containing high nitrate concentrations in infant foods for weaning, bearing in mind that children under 3 months of age are more vulnerable to methemoglobinemia (Betke *et al.*, 1956). Ingestion of high amounts of nitrite causes vasodilation leading to lowering of blood pressure (Asbury & Rhode, 1964) and gastrointestinal lessions (Song & Xu, 1991). Adverse effects of nitrite on the thyroid gland and disturbance of vitamins A and E metabolisms have also been reported (Lhuissier *et al.*, 1976; Van Maanen *et al.*, 1994). The underlying risk of endogenous synthesis of carcinogenic nitrosamines from ingested precursors cannot be overlooked. Bacteria which reduce nitrate to nitrite also catalyse the formation of nitrosamines, and the induction of tumours in animals by simultaneous feeding of nitrate and nitrosatable amines have been reported (Sander, 1968; Lijinsky, 1984; Zhukov *et al.*, 1990). Nitrite is usually secreted in the saliva when food is chewed. Salivary nitrite appeares to be the product of microbial reduction of ingested nitrate (Walters & Smith, 1981; Shapiro *et al.*, 1991) and higher levels occur in the saliva of smokers (Forman *et al.*, 1985). Formation of carcinogenic nitrosamine have occurred when some nitrogenous compounds were incubated with human saliva (Hart & Walters, 1983).

From the data presented herein and from literatures cited, *ogi* should not be stored for a prolonged period. To avoid accumulation of nitrite storage should only be done, where possible, under deep freezing which inhibits nitrite accumulation (Jones & Griffith, 1965; Phillips, 1968).

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