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SHORT COMMUNICATION

Sustainable universal salt iodization in low-income countries – time to re-think strategies?

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Objective: Sustained iodine deficiency control requires sustainable mechanisms for iodine supplementation. We aim to describe the status of salt iodation machines, salt producers' experiences and quality of salt produced in Tanzania.
Methods: Qualitative and quantitative data was collected from the factory sites, observations were made on the status of UNICEF-supplied assisted-iodation machines and convenience samples of salt from 85 salt production facilities were analysed for iodine content.
Results: A total of 140 salt works visited had received 72 salt iodation machines in 1990s, but had largely abandoned them due to high running and maintenance costs. Locally devised simple technology was instead being used to iodate salt. High variability of salt iodine content was found and only 7% of samples fell within the required iodation range.
Conclusion: Although iodine content at factory level is highly variable, overall iodine supply to the population has been deemed largely sufficient. The need for perpetual iodine fortification requires reassessment of salt iodation techniques and production-monitoring systems to ensure sustainability. The emerging local technologies need evaluation as alternative approaches for sustaining universal salt iodation in low-income countries with many small-scale salt producers.
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Introduction

Sustainable control of iodine deficiency disorders (IDD) requires appropriate iodine fortification to reach the entire population, usually salt iodation. However, where small-scale artisanal salt production is widespread, intensive education, technical and financial support for purchase of iodate, packaging materials and the establishment of permanent, complex logistic arrangements are required (UNICEF/WHO, 1993).

In Tanzania, during the 1990s, with funding from the Dutch Government, ILO and one individual producer, UNICEF purchased 72 rugged iodation machines from the Indian subcontinent, as well as chemicals and other related requirements (Kavishe and Mushi, 1993).

In 1999, 86% of urban households and 68% in rural areas stocked iodated salt in Tanzania, better than in many other areas of the world (National Bureau of Statistics [Tanzania] Macro International Inc., 2000; Delange *et al.*, 2001), but still not attaining the WHO recommended criteria of ⩾90% for adequacy at household level (WHO/UNICEF/ICCIDD, 2001). Sporadic IDD surveys indicated sufficient overall iodine intake, but fluctuating urinary iodine concentrations (Lantum *et al.*, 2004; Assey *et al.*, 2006a).

This study examines the status of the previously installed iodation machines and experiences of salt producers in using them.

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Materials and method

We visited salt factories located in Tanga coast, Dar-Es-Salaam, Lindi, Mtwara, Dodoma, Singida and Kigoma regions of Tanzania between 1998 and 2002. These represent nearly all the larger/medium producers and a substantial proportion of the small ones in Tanzania. A simple structured questionnaire was administered to the factory owner/manager. Observations were made of any facilities used for iodation. Convenience salt samples were collected from 85 salt production facilities where salt was in stock and measured for iodine content using the titration method with a precision of 10% and recovery of 95%, thus falling within the recommended levels (WHO/UNICEF/ICCIDD, 2001).

Results

A total of 140 salt works with an annual salt production capacity ranging from one to 20 000 metric tons were visited. Out of 72 machines supplied in the 1990s (Table 1), an average of 5 years after installation, 43 (59.7%) were no longer in operation because they needed major repair, 15 (20.8%) were in good working condition but not used and 14 (19.5%) were reported to be in operation, but used usually only when large order for salt were received.

Reasons given for not using iodation machines included high running costs (fuel/power), ageing (including corrosion), no spare parts available locally and low production/mixing capacities of some machines, causing delays in production and increasing labour costs. The extra cost of transporting salt from the harvesting pans to the stationary medium and large machines was highlighted. Indeed, any increase in production costs risked abandonment. Some producers stated that they had deployed their own resources to iodate their salt, but found that it was impossible to increase prices enough to compensate for this. Meanwhile, conflicts among groups/members of salt associations or cooperatives sharing machines contributed to their being left idle, without proper maintenance or management.

Although the iodation machines were no longer in use, locally devised alternative technologies for iodating salt based on simple equipment requiring a low labour input such as knapsack sprayers, garden spray bottles and local ‘sprinklers’ (tree leaves, sisal threads) had replaced them. Iodated solution was spread on salt in heaps, on mats or on top of 50 kg burlap bags. Bags were placed in an upright position to allow gravitational movement of iodate solution to cover the salt in the rest of the bag. These technologies were observed in most of the salt producing sites.

Tanzania requires 75–100 p.p.m. iodine at production sites, higher than WHO criteria of 20–40 p.p.m., due to expected losses from poor packaging (United Republic of Tanzania, 1994; WHO/UNICEF/ICCIDD, 1996). Table 2 shows that only 7% of the salt samples taken from these iodation facilities were within the required range, 24% were above the required range and 69% were below it. The median moisture content was 1.8% (range 0.2–6.3%) and the median

Table 1 Iodation machines installed from 1991 to 1998, their capacities and operating status on follow-up

Type of machines	*No. of machines*	*Iodation capacity (Tons/h)*	*In good condition but not in use*		*Needing major repair*		*Occasionally in operation*	
			No.	*%*	*No.*	*%*	*No.*	*%*
Large	8	⩾16.0	1	12.5	6	75.0	1	12.5
Medium	7	3.0–5.0	1	14.3	4	57.1	2	28.6
Concrete mixers	25	1.0–3.0	6	24.0	14	56.0	5	20.0
Manual/ rotary	32	0.5–2.0	7	21.9	19	59.4	6	18.7
Total	72	0.5–16.0	15	20.8	43	59.7	14	19.5

Large = iodation capacity of ⩾16 metric tons/h, medium = 3–5 metric tons/h and small (concrete mixers and manual/rotary drum) machine = <3 metric tons/h.

Table 2 Distribution of salt by iodine content, moisture and % water insoluble matter compared to recommended standards ($n = 85$)

Iodine content			*Moisture content*			*Water insoluble matter*	
Range of iodine levels (p.p.m.)	*Salt samples analysed (n)*	*% of samples with iodine*	*Standard authority***	*Required moisture levels (%)*	*% of samples with > than required moisture level*	*Required levels (%)*	*% of samples > than required level*
>100.0	20	23.5	Codex	⩽3.0	24.7	⩽0.5	34.1
75.0–100.0*	6	7.1	Tanzania	⩽6.0	2.3	⩽1.0	2.4
<74.9	59	69.4					

* Recommended iodine levels at factory level in Tanzania.
** Codex and Tanzania’s standards applied to both moisture and water insoluble matter.

content of insoluble matter was 0.8% (0.0–3.5%), respectively. The salt largely conformed to Tanzanian standards but less often to Codex standards.

Since 2003, the Government has set out to do more intensive monitoring of the salt production sites and enforcement of salt iodation regulations in partnership with the Tanzania Salt Producers' Association. However, salt producers stated that in most cases, no serious legal action has been taken against non-compliant facilities, resulting in a market flooded with non-iodated or inadequately iodated salt, which was observed selling at a lower price than adequately iodated salt.

Discussion

Salt iodation, no matter how successful initially, needs to be sustained to achieve lasting IDD elimination. Whereas the iodation machines installed in Tanzania during the 1990s were largely abandoned within a few years, seemingly sustainable alternative iodation methods that emerged later overcame economic constraints. This implies the need to review the internationally recommended strategies and methods for their appropriateness and sustainability in low-income countries with many small-scale salt producers and little prospect of consolidation to a few large salt producers.

The high levels of moisture and impurities found in Tanzanian salt may cause migration and loss of iodine (Diosady *et al*., 1997). We did find highly variable salt iodine content. However, we do not know whether this actually affects population health (WHO/UNICEF/ICCIDD Consultation Report, 1997), nor the extent to which the performance of these technologies can be improved at a reasonable and sustainable cost. So far, despite the economic constraints they face, Tanzania's salt producers seem to be doing a good job in maintaining a fairly adequate iodine status for the population as a whole (WHO/UNICEF/ICCIDD, 1996; MI, 2001; Lantum *et al*., 2004; National Bureau of Statistics [Tanzania] and ORC Macro, 2005; Assey *et al*., 2006a), although this could conceal important variations between population groups or geographic localities (Sundquist *et al*., 1998; Assey *et al*., 2006b).

We do not know the extent to which similar situations exists in other areas with large numbers of small salt producers like West Africa, Bangladesh and Mozambique (MI, 1995). International and national organizations may need to revisit iodation strategies and technologies to determine if more appropriate technologies exist that will offer more sustainable and universal salt iodation in such settings (UNICEF, 1994).

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