QUALITY OF COMMON SALT IN THE TANZANIAN MARKET

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The quality of edible salts in the Tanzanian market has been studied by comparing the levels of iodine, heavy metals and non-metals. Among the 19 analysed local salt samples, only two of them, namely, Kipepeo salt (76.67 mg/kg) and Super salt (79.95 mg/kg), met the recommended level of iodine as per TBS (Tanzania Bureau of Standards) specifications. Other brands have iodine levels below the TBS specification.

Keywords: *iodine, goitre, cretinism*

INTRODUCTION

Iodine is a micronutrient, essential for physical and mental growth. Its usefulness has effectively been detailed in the literature (Hetzel, 1989; Dunn and Van der Haar, 1990; Mannar and Dunn, 1995). In general humans need iodine to make thyroid hormones, produced by the thyroid gland. The hormone controls many chemical processes in different parts of the body, some of these are the normal development and function of the brain and nervous system, and the maintenance of body heat and energy (Dunn and Van der Haar, 1990). The human body requires only minute quantities of this mineral. A health person is required to consume about 80 μg per day on the average or within a range of between 60 - 150 μg per day (Mlingi and Lundqvist, 1981; Kavishe et al., 1988). The World Health Organisation estimates show that about 1.6 billion people in the world, 180 million people in Africa (10 million people of Tanzania) are at risk of Iodine Deficiency Disorders (IDD). According to the TFNC report (1992) about 5.61 millions people in Tanzania (close to 25% of the population) were already affected by various forms of iodine deficiency disorders. Much observed disorders included, goiter at all ages, endemic cretinism (characterised mostly by mental deficiency), deaf-mutism and spastic diplegia, and lesser degrees of neurological defects. The problems are also manifested in expectant mothers, culminating in stillbirths, abortions, congenital abnormalities, low birth weights, infant deaths and endemic cretinism (Qamara and Othman, 1996). From this terrible data the government has seen the necessity of preparing the standard specifications for different edible salts in order to alleviate the IDD problem in the country. Adequate evidence is available both from controlled trials and successful iodinisation programmes that IDD can be reduced and eradicated by correction of the iodine deficiency through salt fortification and also by the iodised oil supplements (Hetzel, 1987).

In the present work an investigation is conducted on the iodine content in edible salts from different manufacturers, the content levels are then compared to the requirements according to the Tanzania Bureau of Standards requirements. Furthermore we report on the levels of metals and non-metals in the salts together with their subsequent effects to human health.

Iodine Production

Iodine is produced mainly by the reduction of naturally occurring iodates. The bisulphite ion is the convenient reductant and the reaction employed is according to the equation;

$$2IO_3^-(aq) + 5HSO_3^-(aq) \rightarrow 3HSO_4^-(aq) + 2SO_4^{2-} + H_2O + I_2$$

The precipitated iodine contains some iodine chloride (ICl) and iodine Bromide (IBr) as impurities. These are removed by distilling iodine over iodide and resublimed according to the reactions below (Soni, 1991, Mohammed et al., 1988);

$$KI + ICl \rightarrow KCl + I_2$$

$$KI + IBr \rightarrow KBr + I_2$$

Chile is the main producer of iodine; other countries include Japan, United States of America (U.S.A.) and India (Kavishe and Mlingi, 1989).

Over-Iodination (Over Production of Thyroxine)

Although iodine is essential to human health, its excess in the body is undesirable. This condition is known as over-iodination, it is associated with elevated levels of thyroid hormones (Hyperthyroidism), a condition that produces rapid heart rates, and other features of a nervous state. These include trembling, excessive sweating, instability and loss of weight (Hetzel, 1989). Extreme hyperthyroidism is termed as thyrotoxicosis and is associated with increased excitability of the cardiac muscle, which may lead to heart failure if medical intervention is delayed. In most cases medical intervention will involve surgical removal of most of the gland or destruction of the same amount by administering radioactive iodine (Taylor et al., 1997).

Areas of the IDD-problem in Tanzania

A survey conducted in Tanzania between the years 1980-1990 showed that various regions have been affected by goitre due to IDD. It was estimated that about 9.3 millions i.e. 41% of the population were at risk of the IDD-problem. And out of 9.3 millions, at least 5 millions were suffering from endemic goitre, 160,000 were cretinism victims and about 450,000 were suspected to suffer from cretinism (TFNC, 1990). In Tanzania, the first goitre cases were documented in the southern highlands in 1953, where the overall goitre prevalence rate of 22% was observed (TFNC, 1990). It was in 1960 that the proposal to iodinate common salt came into effect. Since 1980 a series of goitre prevalence surveys have been carried out mainly by the Tanzania Food and Nutrition Centre. All regions of the country except those bordering the Indian ocean have a significant goitre problem. The highly endemic areas were Mbeya rural, Kyela, Rungwe, Ludewa, Mufindi, Songea rural, Sumbawanga and Mpanda. In Table 1 the prevalence of goitre cases among Tanzania regions is reported.

Table 1: Goitre regional statistics in Tanzania (Kavishe and Mlingi, 1989)

Region	Number of People Examined	Goitre Prevalence (%)
Arusha	1320	36
Coast	1779	5
Dodoma	2205	34
Iringa	2798	47
Kagera	1733	41
Kigoma	3899	61
Kilimanjaro	1501	33
Mbeya	2241	75
Morogoro	1347	54
Mwanza	3018	13
Rukwa	2041	76
Shinyanga	1144	2
Tabora	1005	25
Tanga	2805	14
Singida	2093	7
Mara	2639	63
Ruvuma	2501	55

Control of IDD in Tanzania

In 1997 a National Goitre Expert Committee surveyed 23 districts to make an assessment on the goitre problem. The survey showed clinical goitre to be among 43.2% of males and 52.6% of females with an average prevalence of 47%. (UNICEF, 1997). It was from these results that the Government decided to use a combined approach in combating the source of IDD as part of a health strategy for all by the year 2000. The strategy consisted of oral administration of iodinated oil capsules as a short-term measure in areas where endemicity is high and universal salt iodination for human and livestock consumption as a permanent measure.

It is now well known that the easiest and most economic way of preventing the IDD-problem isthe iodination of common salt. Mixing of iodine with salt is simple and produces no adverse chemical reactions. Salt is consumed daily by every one in fairly consistent amounts and is therefore the most practical vehicle for iodine supplementation. Salt miners have been mobilised to produce iodated salt for both domestic and export purposes.The necessary steps have already been taken to ensure the continuous quality control and monitoring of iodated salt at all levels. Regulations under The Food Act and Miners Act have been formulated/amended to facilitate and sustain the mandatory universal salt iodination in the country. Enforcement of the regulations made under this Act has been effective since January 1995. From that date, marketing of un-iodinated salt for human and livestock consumption was banned.

Heavy-metal Contamination in Salt

Heavy metals is a general collective term which applies to the group of metals and metalloids with a density greater than 6 gcm^{-3}. Although it is a loosely defined term it is widely recognised and it is usually applied to elements such as cadmium, chromium, copper, mercury, nickel, lead and zinc which are commonly associated with pollution and toxicity. Heavy metals can be present in high levels in iodated common salt samples due to the contribution from lake- and sea-water, which are the main raw materials for salt production. A summary of the common ions found in salt sources is shown in table 2. Analysis of heavy metals in foods has become increasingly important in medical, ecological, and pollution studies due to the toxicity of heavy metals. One of the most dangerous characteristics of heavy metals is the accumulation in living organisms, therefore, even when the concentration of the particular ion in the surrounding environment is comparatively low, accumulation over a long period is disastrous to health.

Table 2: Common ions found in sources of salt and their relations to human health (Mannar and Dunn, 1995)

Nutrient	Source	Importance in Human Beings	Associated problems (when in excess)
Nitrate	Oxidation of organic matter	Nil	Methaemoglobin anaemia (Blue baby syndrome), gastric cancer
Sulphate	Oxidation of sulphides, sulphate rocks, fertilisers	Nil	Diarrhoea
Phosphates	Fertilisers, plant and animal wastes, sewages, soil		
Copper	Catchment areas, pots and pans	Enzyme formation - uricase, tyrosinase etc.	Wilson's disease, liver cirrhosis, dementia, thalassemia
Lead	Catchment areas	Nil	Nervousness, mental depression, brain and kidney damage
Cadmium	Catchment areas	Nil	Liver damage, anaemia, dental damage, olfactory damage
Iron	Catchment areas	Haemoglobin and myoglobin production	Nausea, neurosis, cardiovascular collapse
Manganese	Catchment areas	Promoter for; metabolic reactions, skeletal formation, reproductive functions	Psychomotor instability, rigidity of limbs

EXPERIMENTAL

Salt samples

A total of 19 salt samples were used in the study. To obtain a reasonable representative sample for each make, a minimum of five samples of each make were purchased from different retail shops. The samples for each make were then mixed thoroughly and stored in tight plastic containers. The different types of salt used in the study are represented in Table 3.

Instrumentation

A Gallenkamp oven of heating capacity between 0 - 200 °C was used for all drying purposes.

Table 3: Salt samples used in the study

Sample	Location
Mchinga Salt	Mnazi Mmoja (Lindi)
Mapishi Salt	Dar es Salaam
Safi Salt	Dar es Salaam
Kipepeo Salt	Dar es Salaam
Mafia Power Salt	Dar es Salaam
Lindi Salt	Mnazi Mmoja (Lindi)
Mzuri Salt	Mombasa (Kenya)
Star Salt	Dar es Salaam
Dolphin Salt	Dar es Salaam
Kensalt	Mombasa (Kenya)
Nyati Salt	Dar es Salaam
Malindi Salt	Mombasa (Kenya)
Super Salt	Dar es Salaam
Prince Salt	Dar es Salaam
City Super Salt	Dar es Salaam
Pwani Salt	Dar es Salaam
Uvinza Salt	Uvinza (Kigoma)
Kay Salt	Mombasa (Kenya)
Bagamoyo Salt	Sadani (Bagamoyo)

Determination of the concentrations of the anionic radicals, NO_3^-, SO_4^{2-} and PO_4^{3-} was performed using a portable data logging spectrophotometer. While the quantitative determination of heavy metal ions was done using the Perkin-Elmer Model 2380 Atomic Absorption Spectrophotometer.

Iodine Quantification

Iodine in iodated salt in the form of potassium iodate (KIO_3). Thus, before the quantification process, the iodate must be converted to molecular iodine. This is facilitated by the addition of sulphuric acid and potassium iodide solution. The reaction goes to completion releasing molecular iodine. The reaction is represented by equation (1). The released molecular iodine can be quantified by titration against a standardised solution of sodium thiosulphate, $Na_2S_2O_3$, using starch as an external indicator. The titration reaction is represented by equation (2). The quantity of iodine is then converted to ppm using the normal procedure.

Iodine release reaction

$$IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O \quad (1)$$

Ionic reaction for the titration

$$2S_2O_3^{2-} + I_2 \longrightarrow 2I^- + S_4O_6^{2-} \quad (2)$$

In the determinations about 10g of the salt sample were accurately weighed and dissolved completely in about 50 ml of double distilled water. To this solution 1 ml of 2M H_2SO_4 was added followed by 5ml 10% KI to release the iodine. Enough time (about 10 minutes) was left for the reaction to go to completion before addition of 2 ml of the starch indicator. The solution was then titrated against 0.005 M $Na_2S_2O_3$.

During the determination the normal handling procedures were used, among which include,

- the storage of iodine mixture in a dark-cupboard to avoid the re-oxidation of the same to iodide ions,
- the starch is introduced in the titration mixture close to the equivalence point to avoid the formation of iodine-starch complex.

The Determination of the Anions

Sulphate (SO_4^{2-}) Content

The quantitative determination of sulphates ions was carried out using the turbidimetric method (Saxena, 1990). The sulphate content in common salts is usually high due to the fact many sources contribute to its accumulation. Besides domestic sewage and industrial effluent, biological oxidation of reduced sulphur species also add to sulphate levels in water (Saxena, 1990).

Phosphate (PO_4^{3-}) Content

The phosphate ion was determined colorimetrically as dissolved orthophosphate by employing the ascorbic acid method. The method utilizes the reaction of ammonium molybdate and potassium antimonyl tartrate with orthophosphate to form a molybdophosphoric acid that is reduced by ascorbic acid to intense blue coloured species (Saxena, 1990; Morin, 1999). The phosphate concentration is thus determined colorimetrically.

Nitrate (NO_3^-) Content

The nitrate was determined by the cadmium reduction method. In this method the nitrate is reduced almost quantitatively to nitrite in the presence of cadmium. The nitrite produced is determined quantitatively by diazotising with sulphurnilamide and coupling with N-(1-naphthyl)- ethylenediamine to form a highly coloured azo dye that is measured colorimetrically (Saxena, 1990).

The Determination of Heavy Metals

Heavy metals were determined using Perking Elmer 2380 Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

The iodine levels in the studied salt samples are portrayed in Table 4. It is seen that, with the exception of Kipepeo and Super salt samples, all the remaining contain iodine levels that are lower than the quantity recommended by TBS (1996). It is obvious, then that, producers should enhance their iodination procedures to raise the iodine levels to meet the standard. Because iodinated salt is the most practical, effective and satisfactory means of correction of iodine deficiency in most endemias, deliberate efforts should be put in place to control the process by instituting proper monitoring and surveillance procedures.

Table 4: Iodine levels in salt samples.

Salt Sample	Iodine Content (mg/kg)	Sample	Iodine Content (mg/kg)
TBS (1996)	75.1	TBS (1996)	75.1
Kipepeo	76.7	Bagamoyo	67.1
Lindi	68.9	City Super	66.8
Nyati	73.7	Kay	67.1
Star	69.5	Kensalt	69.5
Dolphin	68.2	Malindi	70.3
Mafia Power	67.7	Mzuri	72.6
Mchinga	70.8	Prince	70.9
Mapishi	68.8	Pwani	72.2
Safi	69.3	Uvinza	72.2
Super	79.9		

According to the Table 4, it is also apparent that all the common salts of foreign origin have iodine levels lower than the TBS (1996) value of 75.1 mg/kg. Whether this is a coincidence or otherwise, it may indicate that Tanzanian standards with regard to iodine levels in edible salt is different to the country of origin of these samples. The concerned authorities need to be vigilant in assuring that imported foodstuffs comply with Tanzanian standards. Normally the optimal level of fortification will differ according to local conditions, but considering transportation and storage, it will usually be between 80 – 100 ppm, and the packing should be in plastic containers since they reduce iodine losses (Kochupillal and Pandav, 1987).

The sulphate contents of many samples show a good agreement with the TBS (1996) requirement (Table 5). The standard bureau requires marketable common salt to have a sulphate content of less than 0.5% by mass. The Pwani and Uvinza salt products are the only ones that have exceeded this limit. But as can be discerned from Table 2, the high sulphate content in domestic salt has less detrimental

Table 5:.Some anions found in the studied salt samples salts

SAMPLE	QUANTITY		
	Sulphate (%)	Nitrate (mg/kg)	Phosphate (mg/kg)
TBS (1996)	*0.5*	*5.0*	*0.0*
Mchinga Salt	0.27	0.65	3.48
Mapishi Salt	0.32	2.55	1.10
Safi Salt	0.28	B.D	B.D
Kipepeo Salt	0.49	B.D	B.D
Mafia Salt	0.36	2.81	B.D
Lindi Salt	0.43	0.98	B.D
Star Salt	0.25	0.93	B.D
Dolphin Salt	0.41	B.D	B.D
Nyati Salt	0.04	B.D	B.D
Super Salt	0.49	9.10	0.10
Prince Salt	0.49	B.D	B.D
City Super Salt	0.33	B.D	B.D
Pwani Salt	0.64	B.D	B.D
Uvinza Salt	0.57	3.53	B.D
Bagamoyo Salt	0.35	B.D	B.D
Mzuri Salt	0.06	10.34	B.D
Ken Salt	0.07	5.45	B.D
Malindi Salt	0.12	7.37	B.D
Key Salt	0.03	B.D	B.D
B.D = Below Detectable limit			

effects in the health of users, as compared to the nitrate content, for instance. The effects of sulphate can be detected immediately and treated as opposed to those of nitrate. With that regard this component should not be of much concern to the users' health.

For the phosphate anions, it is observed that Mchinga salt, Mapishi salt and Super salt contain some significant amounts, whereas the rest have no detectable amount. In the case of nitrate ion, it is observed that Mchinga salt, Mapishi salt, Mafia power salt, Lindi salt, Super salt, and Uvinza family salt contain some amounts of nitrates; while the rest have negligible amounts. It should be noted that, TBS specifications, requires common salt not to have more than 5.0 mg/kg of nitrate ions and should not have phosphate ions altogether. The high content of nitrate ions in common salt has serious health hazards, some of them are, methaemoglobin anaemia (Blue Baby Syndrome) and gastric cancer (Table 2). Therefore the high levels of nitrate ion in products such as Mzuri salt (10.34 ppm), Super salt (9.10 ppm) and Malindi salt (7.37 ppm) should be of much concern to the users of the products.

The results from Table 6 clearly show that all salt samples contain iron with the range varying between 4.9 mg/kg (Dophin salt) and 20.6 mg/kg (Star salt). Most of the salt samples have iron-values exceeding the minimum recommended by TBS, i.e. 5.0 mg/kg. The role of iron in human health is well known and as such it can not be overemphasized in this contribution.

Since the copper metal concentration value as recommended by TBS is 2.0 mg/kg then most of the salt samples have higher value of copper than the recommended value. The tables also show that, most of the salt samples do not contain manganese metal, and those, which contain the metal it is on the low side with no detrimental effects. Special attention, however, need to be addressed on the manganese content of Nyati salt.

CONCLUSION AND RECOMMENDATIONS

The motive of the present project was to study the quality status of edible salt in the Tanzanian retail shops, by looking into the levels of iodine, heavy metals and common radicals present as, compared to the TBS specifications. From the project results, the following observations have been made: among the 19 analysed local salt samples, only two of them met the recommended level of iodine as per the TBS recommendations. These are the Kipepeo salt and Super salt with the iodine contents of 76.7 and 79.9 mg/kg, respectively. The rest of the salt samples have lower values of iodine than the minimum recommended. The closeness of the values to the minimum value as per TBS specifications may indicate a possible loss during transportation and storage. These factors, however, should not influence our judgement for the suitability of the samples.

For the sulphate ion content, only Pwani salt and Uvinza salt with contents of 0.64 and 0.57 mg/kg, respectively, were found to have values beyond the recommended maximum value of 0.5 mg/kg, the rest have lower contents than the maximum required by the standards body. Phosphate ions were not detected in most of the samples except for the Mchinga, Mapishi and Super salt samples. The levels of phosphate ion, however, are not of large scale to cause any alarm. With regard to nitrate ion contents, it has been established that most of the salt samples comply to the TBS requirement, except for the Super salt, Mzuri salt, Malindi salt and Ken salt.

For the heavy metals, it is observed t that all samples have acceptable values of iron contents. Some critical attention should, however, be drawn to the high level of copper ion in the salt. Only three samples have lower than the maximum copper ion content that is recommended by TBS. For the manganese ions contents, the results indicate that about half of the samples have contents lower than the detection limit, however, special attention should be drawn to the manganese content of Nyati salt (16.0 mg/kg), which is too high.

In order to cope with the IDD problems Tanzania, it is recommended that responsible organs make regular inspection on the quality of common salt in the market, with special attention on the levels of iodine, heavy metals and non-metals. In areas severely affected with cretinism and goitre, cattle feeds should be iodated so that dairy products serve as a supply root of the nutrients to the public.

Since the iodine content is of paramount importance in common salt, it is imperative that deliberate efforts be taken to identify the real source of its low content. There are two possibilities to this end, the first is inadequate iodination during manufacture and secondly, losses of iodine during transportation and storage. With such knowledge manufacturers can be advised, accordingly, so as to compensate for the losses.

Table 6: Concentration of heavy metals as compared to TBS recommendations

Sample	Fe (mg/kg)	Cu (mg/kg)	Mn (mg/kg)
TBS (1996)	5.0	2.0	1.0
Mchinga salt	13.1	3.5	B.D
Mapishi salt	13.7	3.5	B.D
Safi salt	15.1	4.1	B.D
Kipepeo salt	15.6	3.8	B.D
Mafia salt	18.8	4.1	B.D
Lindi salt	18.4	4.8	6.4
Star salt	20.6	4.3	2.4
Dophin salt	5.2	4.6	1.7
Nyati salt	6.1	4.9	16.0
Super salt	7.5	5.4	2.4
Prince salt	6.0	5.3	0.8
City super salt	8.4	5.6	B.D
Pwani salt	6.5	1.5	B.D
Uvinza F.salt	7.4	0.8	7.2
Bagamoyo salt	7.5	1.1	B.D
Mzuri salt	20.1	4.6	B.D
Ken salt	4.9	4.5	1.7
Malindi salt	5.9	5.1	2.1
Kay salt	7.4	1.0	B.D

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