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The use of iodised salt in the manufacturing of processed foods in South Africa: bread and bread premixes, margarine, and flavourants of salty snacks

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Salt is widely used by the food industry, but information on the use of iodised salt as an ingredient in the manufacturing of processed foods in South Africa is not available. The iodine content of salt used in the manufacturing of bread, margarine and salty snack flavourants was investigated in a cross-sectional descriptive study. Questionnaire information and salt sampled on 1 day per week for 5 consecutive weeks were obtained from 12 food manufacturers (eight bread and bread premix manufacturers, two margarine manufacturers and two salty snack flavourant manufacturers). The iodine concentration of salt samples was analysed using the potentiometric titration method. Eleven of the 12 manufacturers surveyed reported that they used non-iodised salt. The reported reasons for using non-iodised salt included properties of the final product, health reasons, and financial considerations. However, substantial amounts of iodine were found in the salt of one-third of these manufacturers ($n = 4$), ranging from a mean content of 39–69 ppm. Three of these four particular manufacturers distributed their products countrywide. This information serves as a strong indication that iodised salt does not necessarily cause the adverse affects that food manufacturers fear may affect their products. Although the amounts of iodine in the salt were variable, our results showed that an appreciable percentage of the food companies used iodised salt unknowingly in the manufacturing of frequently consumed processed foods, and this may have a considerable impact on the daily iodine intake of consumers.

Introduction

Iodine deficiency is regarded as the most common preventable cause of brain damage and mental retardation worldwide (World Health Organisation/United Nations Children's Fund/International Control Council for Iodine Deficiency Disorders, 1994; Mannar & Dunn, 1995; Delange, 1998; Jooste, 2000). Other manifestations of this deficiency include lethargy and physical sluggishness, goitre, hypothyroidism, reproductive failure and cretinism, which are usually collectively referred to as the iodine deficiency disorders

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(IDD). Such disorders not only impact on the individual, but may impact on entire populations, resulting in economic stagnation due to decreased productivity by iodine-deficient individuals (Mannar & Dunn, 1995; Houston & Kavishe, 1999).

Universal salt iodisation is the method of choice for the prevention of IDD as it is regarded the most successful sustainable solution (Mannar & Dunn, 1995; Mannar, 1996). The successes of salt fortification in eliminating IDD have been reported in many parts of Europe and in northern America; the percentage of the world population at risk of IDD decreased from 28.9% in 1994 to 13.7% in 1997 due to such programmes (Delange, 1998). In South Africa, mandatory iodisation of table salt at a level of 40–60 parts per million (ppm) replaced optional iodisation in December 1995, using potassium iodate as the fortificant (Jooste *et al*., 2001). However, salt used in the manufacturing of processed foods, and salt packaged in bags of 20 kg or more, is exempted from mandatory iodisation (Department of Health, 1995).

Despite remarkable improvements in the availability of iodised salt and improved iodine status of children, 37.6% of South African households in 1998 were still using under or non-iodised salt (Jooste *et al*., 2001), and in a national survey 16.2% of schools surveyed exhibited evidence of persisting iodine deficiency (Immelman *et al*., 2000).

Studies in South Africa have examined iodised salt and its use as household table salt, however, information on the use of iodised salt as an ingredient in the manufacturing of processed foods is not available. It is known that salt is widely used in the food industry (Mannar & Dunn, 1995), but whether in South Africa this salt is iodised remains unanswered. The National Food Consumption Survey conducted in South Africa on children aged 1–9 years old in 1998 found that bread and margarine were among the 10 most frequently consumed foods in the country (Labadarios *et al.*, 1999). In addition, bread had earlier been identified as being the most common single staple food consumed amongst the four main population groups of South Africa (Jooste *et al.*, 1994). The South African Demographic and Health Survey conducted in 1998 found that black South Africans frequently consume salty snacks such as potato crisps (Department of Health, Medical Research Council & Macro International, 2001). For these reasons, bread, margarine and salty snacks (including potato crisps and puffs) were considered appropriate foodstuffs for investigating the iodine content of the salt used by the processed food industry in South Africa.

An examination of the use of iodised salt within the food industry will serve to help with the surveillance and monitoring of the national salt iodisation programme by providing information on the iodine content of non-discretionary salt. This information could potentially have implications in terms of the regulatory levels of iodine in iodised salt, and it may also contribute to a more accurate understanding of the amount of iodine consumed by South Africans. Therefore, the aim of the present study was to investigate the use of iodised salt in the manufacturing of some of the widely consumed processed foods on the market (i.e. bread, margarine, and salty snacks).

Methods

Food manufacturers

A total of 17 food manufacturing companies, situated in three of the nine provinces in South Africa (Western Cape, Gauteng and KwaZulu-Natal) and in two neighbouring countries (Lesotho and Swaziland), were selected for this cross-sectional descriptive study. These companies consisted of 11 bread manufacturers (two of which were bread premix companies), three margarine manufacturers, and three flavour houses that manufacture the flavourants for salty snacks. The bread premix companies produce and distribute bread premixes to in-store bakeries in supermarkets, as well as smaller convenience-store chains. Salt is already included in the bread premix, to which the bakeries add flour, yeast and water. The 17 companies were selected non-randomly by identifying the main or well-known manufacturers of the

three selected processed foods. In the case of manufacturers who have more than one branch in a province, only one branch was included if the branches have the same salt supplier.

Sample and data collection

Manufacturers were initially contacted telephonically and it was explained what participation in the study would entail. Subsequently they were each mailed an information sheet outlining the requirements of the study, a consent form, a questionnaire to be completed by the manufacturer, five small plastic zip-lock bags (for the collection of salt samples), and a self-addressed envelope, in which the samples and questionnaires were to be returned.

The self-administered postal questionnaire was used to gather information on the type of salt (iodised or non-iodised) used by each manufacturer and the reasons for its use, as well as the name of the manufacturer's salt supplier. This questionnaire was piloted on one manufacturer, not included in the final sample, prior to the implementation of the study.

During the preparatory phase of the study, manufacturers were contacted telephonically to enquire about the rate of salt usage in terms of the approximate number of bags used weekly and, based on this information, it was decided to implement a weekly sampling of salt. The manufacturers were requested to collect 20 g salt samples from the salt that was used in the manufacturing of their products at the time of the study. This was repeated on 1 day per week for 5 consecutive weeks to provide a reliable reflection of the iodine content of the salt used by the respective manufacturers. Manufacturers returned the five salt samples, together with their signed consent form, either via post or they were collected personally by the researchers. The study protocol required that the manufacturers were to be reminded up to four times (either via e-mail or telephonically) to collect salt samples and complete the questionnaire.

Salt analysis

The salt samples were kept in their sealed plastic bags in a dark environment until they were analysed. All salt samples were analysed for the iodine concentration by the same analyst using the potentiometric titration method on a Metrohm Model 751 GPD Totrino autotitrator (Swiss Lab, Cape Town, South Africa). The autotitration establishes the stoichiometric endpoint of the dissolved salt solution with a platinum indicator electrode. Using this method, the recovery of iodine in an iodine-spiked solution was 99.7%, and the coefficient of variation was 1.56 at an iodine concentration of 20 ppm and 0.31 at a concentration of 50 ppm in our laboratory.

Results

Twelve of the 17 manufacturers returned a complete set of information, each consisting of the questionnaire and five salt samples, representing a response rate of 70.6%. Only companies within the borders of South Africa responded; these included six bread manufacturers, the two bread premix manufacturers, two margarine manufacturers, and two flavour houses. Reasons for not responding included samples and questionnaires being lost in the post, and individuals who were responsible for participating in the study leaving their positions of employment without notifying the researchers.

Questionnaire information

Eleven of the companies reported that they used non-iodised salt in the manufacturing of their products at the time of the study, and the remaining one stated that they used iodised salt. Ten companies purchased salt in 50 kg bags, one company in 25 kg bags, and one company in 20 kg and 1000 kg bags.

The reasons given by manufacturers for using non-iodised salt can be grouped into categories related to properties of the final product, health reasons, and financial considerations. In terms of properties of the product, three companies stated that iodine would affect its stability, and that this may affect the taste. One company stated that

iodine might either enhance or suppress the flavour of their products. In another response, a flavourants manufacturer stated that they use salt as a carrier for flavour concentrates, spices, and oleoresin, and in order to ensure the stability of their flavourants they require a 'pure product with no additional chemicals'.

With regards to health reasons, one company stated they were concerned that many people may be allergic to iodine and therefore they use non-iodised salt. Another reported that they use non-iodised salt because they do not wish to expose their consumers to an overdose of iodine. A third company merely stated they used non-iodised salt for health reasons.

Of the remaining four companies that reported using non-iodised salt, two did so because it is less costly than iodised salt, while the other two did not provide a reason. The single company that reported the use of iodised salt stated that iodine is added to salt in foodstuffs 'to aid the function of the thyroid gland'.

Iodine concentration of salt samples

The mean iodine content of salt samples obtained from the 12 manufacturers is summarised in Table 1. One-third of the manufacturers ($n = 4$) had substantial amounts of iodine in their salt, with means ranging from 39 to 69 ppm. These included one bread manufacturer, a margarine manufacturer, and both the salty snack flavourant manufacturers. Three of these four particular manufacturers reportedly distributed their products countrywide; the fourth supplies a metropolitan area. The remaining two-thirds ($n = 8$) of the manufacturers used salt containing either no or only trace amounts of iodine. Variation in the mean iodine content of the salt was found between manufacturers, as well as within manufacturers, where the largest variation found was from 58 to 100 ppm in the samples provided by Manufacturer 11.

The questionnaire data revealed that manufacturers obtained their salt from various sources, including salt producers, salt traders, and general traders. Manufacturers 5, 11 and 12, which had the highest mean iodine concentrations (61–69 ppm), purchased their salt in 50 kg bags from the same salt producer.

Discussion

Unlike previous studies in South Africa, which have examined iodised salt and its use as household table salt, the present study has provided information on the iodine

Table 1. Mean iodine content of salt samples

		*Iodine content**		
Product	*Manufacturer*	*Mean*	*Range*	*Scale of distribution*
Bread	1	0	0–1.2	Metropole (Pretoria)**
	2	0	0–1.4	Metropole (Cape Town)**
	3	0	0–0.5	Provincial (Western Cape)
	4	0	0–1.2	Local (Cape Town suburb)***
	5	61	33.7–71.4	Metropole (Cape Town)**
	6	0	0.5–0.6	Metropole (Cape Town)**
Bread premixes	7	0	0.5–1.2	Provincial (Western Cape, Eastern Cape, Northern Cape, Gauteng, Free State)
	8	0	0–0.8	Provincial (Western Cape)
Margarine	9	0	0–0.5	Countrywide
	10	39	22.6–54.3	Countrywide
Salty snack flavourants	11	69	57.5–99.6	Countrywide
	12	67	60.9–70.6	Countrywide

*Measured in parts per million (equivalent to mg/kg).
**This refers to metropole areas with radii of up to 100 km.
***This refers to a distribution area of less than 10 km.

content of salt that is used by the bread, margarine and salty snack flavourant industries. Although 92% (11 out of 12) of the companies surveyed reported that they used non-iodised salt, the salt used by four of these companies contained substantial amounts of iodine, ranging from 39 to 69 ppm. Considering that the products of three of these four particular manufacturers are reportedly distributed countrywide, while the fourth covers a metropolitan area, this may potentially have a significant impact on the iodine intake of a large number of individuals consuming these products. Consequently, these companies are most likely, and unknowingly, contributing to the elimination of iodine deficiency in the country. Interestingly, the salt used by the company that reported the use of iodised salt in their products contained no iodine.

The potential contribution of iodised salt used for baking bread, and of margarine spread on bread, towards the daily iodine intake could be estimated. Generally, bread contains approximately 450 mg sodium per 100 g bread. After converting the amount of sodium to sodium chloride (salt), one slice of bread (30 g) contains approximately 0.343 g of salt. Using an iodine content of 61 ppm, which was found in the case of one bread manufacturer, and assuming a 20% loss (World Health Organisation/United Nations Children's Fund/International Control Council for Iodine Deficiency Disorders, 2001) of iodine during the baking process, one slice of bread could provide an individual with 16.7 μg of iodine.

If an individual was to consume five slices of this bread (150 g) in a day, the bread would provide 83.7 μg iodine, which is equivalent to 56% of the recommended daily allowance (RDA) of 150 μg iodine/day for adolescents and adults (World Health Organisation/United Nations Children's Fund/International Control Council for Iodine Deficiency Disorders, 2001). However, owing to the fact that iodine losses during cooking are variable (Goindi *et al*., 1995), and that information is not available on the losses of iodine during commercial baking, the iodine losses may be greater than 20%. According to Kuhajek & Fiedelman (1973), the iodine retention was between 50 and 80% during the processing and storage of white bread. Assuming this, and using a 50% loss instead of 20%, the iodine provided by five slices of bread containing salt iodised at 61 ppm would be 52.3 μg, or 35% of the RDA.

Similarly, it would be useful to consider the contribution to the daily iodine intake that bread spread with margarine could make. It could be calculated that 6 g margarine, generally used per slice of bread, contains approximately 2.34 μg iodine using salt iodised at 39 ppm. Allowing for a 20–50% loss of iodine, the margarine used on five slices of bread would amount to 5.9–9.4 μg iodine. Therefore, an individual consuming five slices of bread (containing salt iodised at 61 ppm) spread with a total of 30 g margarine (containing salt iodised at 39 ppm), would provide an individual with between 58.2 and 93.1 μg iodine, or 39–69% of the RDA of 150 μg iodine.

These estimations, which may vary considerably depending on the iodine content of the salt and the potential losses of iodine during processing, nevertheless illustrate the important and significant contribution that the use of iodised salt in the bread and margarine industries can make to the daily iodine intake of individuals. Calculations made with respect to salty snacks indicated that these products could also make modest contributions to the daily iodine intake. The significant contribution that these processed foods may make towards the daily iodine intake could therefore enable individuals to use less added salt and still achieve sufficient iodine intakes.

As a reason for using non-iodised salt, manufacturers stated that iodised salt may affect the stability, colour, flavour and taste of their products. Similar concerns were expressed by countries in the Middle East and Eastern Europe, where the food industry was reluctant to use iodised salt (West & Merx, 1995). A particular concern was that the use of iodised salt would cause certain foods, including starchy products and pickles, to turn blue after storage. According to the review of West & Merx (1995), studies that examined the influence of iodised salt on food quality, where the iodine concentration

in the salt was within the normal range, reported almost no adverse effects.

With regard to the use of iodised salt as an ingredient in bread, the Netherlands has been using iodised salt successfully in the baking of bread since 1942. In addition, in the USA, iodate has been used with success for many years as a bread conditioner (Dunn, 1996), and therefore the use of it is evidently not ruled out. This, together with the fact that four manufacturers included in our study were using salt that is iodised without any obvious negative effects, serves as a strong indication that iodised salt does not necessarily cause the adverse affects that food manufacturers fear may affect their products.

Health-related reasons given by manufacturers for using non-iodised salt included concerns that some individuals may be allergic to iodine, and that consumers could be exposed to an overdose of iodine. Although allergy to iodine is a theoretical possibility, reports of it are extremely rare (World Health Organisation, 1996). Essentially, it would be an allergic reaction to the presence of iodine, which is present in air, water, a variety of food sources (Hetzel, 1996; Mahan & Escott-Stump, 1996; Houston & Kavishe, 1999), and iodised salt.

Individuals consuming sufficient amounts of iodine and who are exposed to excess iodine usually remain euthyroid owing to adaptive mechanisms (World Health Organisation, 1996). Despite this, it has been reported that susceptible individuals, mostly severely iodine-deficient individuals older than 40 years of age with nodular goitres who were exposed to an acute increase in iodine intake (Delange, 1998; Stanbury *et al.*, 1998; Delange & Lecomte, 2000), have developed iodine-induced hyperthyroidism following daily iodine intakes three to 20 times greater than the RDA (World Health Organisation, 1996). Iodine-induced hyperthyroidism, in which the fundamental developmental event is autonomy of thyroid function (Stanbury *et al.*, 1998), is the most important side effect that may develop as a result of an increased iodine intake (Todd, 1999). Small amounts of additional iodine provided by the use of iodised salt in the food manufacturing industry are, however, unlikely to result in iodine-induced hyperthyroidism in the South African population owing to the improved iodine status as reported in several South African studies (Immelman *et al.*, 2000; Jooste *et al.*, 2000).

Even though the iodine status of South Africans improved markedly after the introduction of mandatory iodisation, 37.6% of South African households are using inadequately iodised salt (Jooste *et al*., 2001) and vulnerable subsets of the population are still exposed to under- and non-iodised salt. Owing to this, the use of iodised salt in a staple food such as bread, as well as in other frequently consumed processed foods, could play a considerable complementary role to the national salt iodisation programme in the elimination of iodine deficiency and the sustenance of adequate iodine status.

In conclusion, the present study demonstrated that an appreciable proportion of the selected food manufacturers in South Africa used iodised salt in the manufacturing of their products. In addition, these manufacturers were not aware that the salt they were using was iodised. The use of iodised salt in the manufacturing of processed foods may therefore serve as a beneficial complementary component to the national salt iodisation programme, contributing to the sustainable elimination of iodine deficiency.

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References

Delange F (1998): Risks and benefits of iodine supplementation. *Lancet* **351**, 923–924.

Delange F & Lecomte P (2000): Iodine supplementation: benefits outweigh risks. *Drug Saf.* **22**, 89–95.

Department of Health (1995): Regulations relating to salt (No. 996). Foodstuffs, cosmetics and disinfectants regulations. *Government Gazette* **16514** (7 July), 12.

Department of Health, Medical Research Council & Macro International (2001): *South African Demographic and Health Survey, 1998*. Pretoria: Department of Health.

Dunn JT (1996): The use of iodized oil and other alternatives for the elimination of iodine deficiency disorders. In *S.O.S. for a Billion: The Conquest of Iodine Deficiency Disorders*, eds BS Hetzel & CS Pandav, 2nd edn, pp. 119–128. New Delhi: Oxford University Press.

Goindi G, Karmarkar MG, Kapil U & Jagannathan J (1995): Estimation of losses of iodine during different cooking procedures. *Asia Pacific J. Clin. Nutr.* **4**, 225–227.

Hetzel BS (1996): S.O.S. for a billion — the nature and magnitude of the iodine deficiency disorders. In *S.O.S. for a Billion: The Conquest of Iodine Deficiency Disorders*, eds BS Hetzel & CS Pandav, 2nd edn, pp. 3–29. New Delhi: Oxford University Press.

Houston R & Kavishe FP (1999): Iodine: physiology, dietary sources and requirements. In *Encyclopedia of Human Nutrition*, eds MJ Sadler, JJ Strain & B Caballero, pp. 1138–1153. London: Academic Press.

Immelman R, Towindo T, Kalk WJ, Paiker J, Makuraj S, Naicker J & Omar S (2000): *Report of the South African Institute for Medical Research on Iodine Deficiency Disorder Survey of Primary School Learners for the Department of Health, South Africa*. South African Institute for Medical Research.

Jooste PL (2000): Effects of mandatory iodization on the iodine content of retailer and household salt in South Africa. *Proceedings of the 8th World Salt Symposium, Salt 2000*, ed Geertman RM, pp. 1003–1007. Amsterdam.

Jooste PL, Langenhoven ML, Wolmarans P & Benadé AJS (1994): National trends in bread consumption. *S. Afr. J. Food Sci. Nutr.* **6**, 86–89.

Jooste PL, Weight MJ & Lombard CJ (2000): Short-term effectiveness of mandatory iodization of table salt, at an elevated iodine concentration, on the iodine and goitre status of schoolchildren with endemic goitre. *Am. J. Clin. Nutr.* **71**, 75–80.

Jooste PL, Weight MJ & Lombard CJ (2001): Iodine concentration in household salt in South Africa. *WHO Bull.* **79**, 534–540.

Kuhajek EJ & Fiedelman HW (1973): Nutritional iodine in processed foods. *Food Technol.* **27**, 52–53.

Labadarios D, Kotze TJVW, Steyn N, Maunder E, MacIntyre U, Gericke G, Huskisson J, Vorster HH, Swart TR, Dannhauser A & Nesamvuni AE (1999): *The National Food Consumption Survey (NFCS) of Children aged 1–9 years in South Africa*. South Africa: Directorate of Nutrition, Department of Health.

Mahan LK & Escott-Stump S (1996): *Krause's Food Nutrition & Diet Therapy*, 9th edn, pp. 149–151. Philadelphia, PA: WB Saunders Company.

Mannar MGV & Dunn JT (1995): *Salt Iodization for the Elimination of Iodine Deficiency*, pp. 1–8. The Hague: International Council for the Control of Iodine Deficiency Disorders.

Mannar MGV (1996): The iodization of salt for the elimination of iodine deficiency disorders. In *S.O.S. for a Billion: The Conquest of Iodine Deficiency Disorders*, eds BS Hetzel & CS Pandav, 2nd edn, pp. 99–118. New Delhi: Oxford University Press.

Stanbury JB, Ermans AE, Bourdoux P, Todd C, Oken E, Tonglet R, Vidor G, Braverman LE & Medeiros-Neto G (1998): Iodine-induced hyperthyroidism: occurrence and epidemiolody. *Thyroid* **8**, 83–100.

Todd CH (1999): *Hyperthyroidism and Other Thyroid Disorders: A Practical Handbook For Recognition and Management*, p. 7. Geneva: World Health Organisation.

West CE & Merx R (1995): *Effect of Iodized Salt on the Colour and Taste of Food*. New York: United Nations Children's Fund.

World Health Organisation (1996): Statement on safety of iodized salt and iodized oil: iodine and health eliminating iodine deficiency disorders safely through salt iodization. In *S.O.S. for a Billion: The Conquest of Iodine Deficiency Disorders*, 2nd edn, eds Hetzel BS & Pandav CS, pp. 357–365. New Delhi: Oxford University Press.

World Health Organisation/United Nations Children's Fund/International Control Council for Iodine Deficiency Disorders (1994): *Indicators for Assessing Iodine Deficiency Disorders and their Control Through Salt Iodization*, p. 2. Geneva: World Health Organisation.

World Health Organisation/United Nations Children's Fund/International Control Council for Iodine Deficiency Disorders (2001): *Assessment of Iodine Deficiency Disorders and Monitoring their Elimination: A Guide for Programme Managers*, pp. 7–22. Geneva: World Health Organisation.