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Research article

Salt production and iodization practices among artisanal salt producers in selected districts within the Greater Accra and Central Regions of Ghana

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ABSTRACT

Background: This study was conducted to assess salt production and iodization practices by artisanal salt producers located at six districts across Greater Accra and Central regions.
Methods: One Hundred and Sixty-Six (166) salt miners in Greater Accra and Central Regions were interviewed using a structured questionnaire and their production sites inspected for salt iodization practices.
Results: The study revealed that salt iodization is not practiced among majority (69.28 %) of artisanal salt producers. They were conversant with salt iodization (93.98 %) and had fair knowledge on the health effects on consumers when iodine is absent in salt. Some of the producers attributed the nonadherence to the mandatory salt iodization to the unavailability of potassium iodate/iodide on the market. All artisanal salt producers interviewed utilise the solar evaporation method for salt production. The evaporation is done on tarpaulin/polyethylene lined pans and concrete pans. The tarpaulin/polyethylene lined pans were predominantly used in Greater Accra, and concrete pans in Central region.
Conclusion: For Ghana to increase availability of iodized salt on the market and improve household consumption of iodized salt, regulatory authorities need to enforce the laws and regulations on salt iodization and also create the enabling environment for artisanal salt producer to have access to potassium iodate for production.

1. Introduction

Iodine is an essential micronutrient, required for the body to produce thyroid hormones which control metabolism and many other bodily functions. It is also required during pregnancy and infancy for proper bone formation and brain development [1]. A diet low in iodine is the main cause of iodine deficiency (ID); a condition which adversely impacts public health. Mild ID leads to significant loss of cognitive capacity (approximately 13.5 intelligence quotient points at the population level) and goiter. In its most severe form, ID leads to Iodine Deficiency Disorders (IDDs) which include cretinism, stillbirth, miscarriage and high infant mortality [2–4].

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1.1. Prevention of IDD through iodine fortification

Inadequate iodine nutrition and Iodine Deficiency Disorders (IDDs) are global health concerns which have been the subject of discussions at many international health summits since the 1990s. Accordingly, in 1994, the World Health Organization (WHO) recommended Universal Salt Iodization (USI) as a global strategy to facilitate adequate iodine nutrition for all individuals. For a century, fortification of salt with iodine have been the most widespread, long-term and effective preventive measure against IDDs [5]. The salt is merely utilized as a safe and excellent carrier for iodine and other nutrients, consumed at relatively constant, well-definable levels by all people within a society independent of economic status. Thus, with this strategy, WHO sought to attain a minimum of 90 % household consumption of adequately iodized salt for the eradication of IDDs [6].

1.2. Salt production in Ghana

Salt production in Ghana occurs primarily at five regions, i.e. four coastal regions (Greater Accra, Central, Western and Volta regions) and one non-coastal region (Northern region). The geographical location, climatic and meteorological conditions in Ghana are suitable for solar salt production [7].

Globally, there are three main salt production techniques i.e. solar evaporation, rock salt mining and vacuum evaporation techniques. In Ghana, particularly along the coasts and amongst artisanal salt producers, solar evaporation is the common and predominantly method used. For centuries this method has been practiced along coasts in many coastal countries [8]. Solar evaporation involves collection and introduction of salty water either from sea, marine lagoons or dugout wells into series of concentration pans for continual evaporation, and finally into crystallization pans, where Sodium Chloride (NaCl) crystallizes out at brine density of 25.7 °Baumé and is harvested.

There are two (2) main variations in this procedure which ultimately influences salt quality, i.e. salt works and salt winning sites. Salt production from salt works are practiced predominantly by large scale producers whilst salt winning is practiced by medium and small scale producers. Reports indicate that salt from winning sites is generally of lower quality as compared with the requirements of Ghana Standards Authority. This low quality is attributable to uncontrolled processing conditions at the winning sites [8].

1.3. Justification

Ghana enacted USI under the Food and Drugs Act 523 in 1996 and subsequently developed and implemented the USI strategic plans I (2005–2007) and II (2009–2011) through the National Salt Iodization Committee, to facilitate sustainable elimination of IDDs (GSS GHS ICF International, 2015). However, after the project implementation phase, the interagency collaborations gradually disintegrated primarily due to lack of funds for acquisition of qualitative test kits for field monitoring, unavailability and inconsistent supply of potassium iodate, inconsistent enforcement and field monitoring. Presently, there are no strict enforcement and monitoring regimes for the mandatory iodization of edible salt in commerce as stipulated in Part 7, Section 107, Subsection 1–2 of the Public Health Act, 2012, Act 851. Consequently, iodization status of salt produced particularly by artisanal producers in Ghana cannot be ascertained.

Unsurprisingly, research on iodine consumption in Ghana over the past few years point to low iodine nutrition amongst the populace, particularly for vulnerable groups, i.e., pregnant women and infants [9–13].

Low iodine nutrition coupled with the potential adverse implications of ID on human health, is a public health concern. This therefore motivates for development and implementation of a national strategy for mandatory iodization of edible salt in Ghana. However, to facilitate this, it is imperative to assess the current situation at major salt producing regions in respect of production and iodization practices, particularly amongst artisanal salt producers, and to make recommendations accordingly.

It is in view of the aforementioned that this study was conducted to assess the current salt production and iodization practices by artisanal salt producers located at six districts across Greater Accra and Central regions.

2. Material and methods

2.1. Research design

A cross-sectional study was conducted from November to December 2022 on current salt production and iodization practices by artisanal salt producers located in six districts within Greater Accra and Central regions.

In selecting the study participants, a stratified technique was used to select the artisanal salt producers for the study, with each District constituting a stratum. It was practically impossible to accurately estimate population size of these artisanal salt producers across the country [7] hence, sample size for the survey was determined using the formula;

$$\frac{n = t^2 \times p(1-p)}{M^2}$$

(Where, n = sample size, t = confidence level at 99 % i.e. 2.576, p = estimated prevalence of variable of interest i.e. 50 %, m = margin of error at 10 %). Sample size was thus determined to be ***n = 166 respondents***.

The sample size was divided equally among the two regions (Greater Accra and Central), with the assumption that the number of

artisanal salt producers are the same in these regions. A minimum number of Eighty-Three (83) artisanal salt producers were selected in each region using the convenience sampling technique and self-administered with the questionnaire.

2.2. Instrumentation

Data for the study was collected in December 2022, through interviews using a structured questionnaire. The questionnaire to obtain requisite information on salt winning and iodization practices were designed and administered to artisanal salt producers at the two regions. The questions comprised of both open-ended and close-ended questions, and the scope covered include socio-demographics of respondents (i.e. age, gender, education and years of experience), awareness and knowledge of artisanal producers in respect of salt production/iodization, potassium iodate sourcing, concentration of potassium iodate/iodide used (in ppb, where applicable) and the challenges with salt iodization. Date of the interviews and GPS addresses of the respective interview sites within districts were also recorded.

2.3. Data collection

A total of 166 personal interviews were conducted using a structured questionnaire. The interviews were conducted in six districts in the central and Greater Accra regions (see Fig. 1). Districts selected in Central region were Komenda Edina Eguafo Abirem (KEEA, Elmina), Gomoa East (Kasoa Nyanyano), Gomoa West (Apam) and Effutu districts (Winneba) and districts in Greater Accra region were Ada East (Songor Lagoon, Ada) and Ningo/Prampram districts (Prampram).

2.4. Statistical analysis

Statistical analyses of the data was done using both Epi Info 7 software and Microsoft Excel 2016. Simple descriptive methods such as frequency distribution were used to explore the baseline characteristics of the population. Descriptive statistics such as means, percentages, standard deviations and frequencies were used to describe awareness of salt iodization and iodine deficiency, knowledge on salt iodization, salt production practices of respondents.

3. Results

3.1. Demographic characteristics

A total of 166 artisanal salt producers were interviewed. The female respondents were 36 (21.7 %) whiles 130 (78.3 %) of the respondents were male (Table 1). The mean age of the respondents was 45years (Std Dev of ±1.9) with their ages ranging from 17 to 80 years. Majority (30.1 %) of the respondents were within the age range 40–49years and had a low level of education i.e. basic education (54.22 %). Years of experience in salt production ranges from 6 months to 40years.

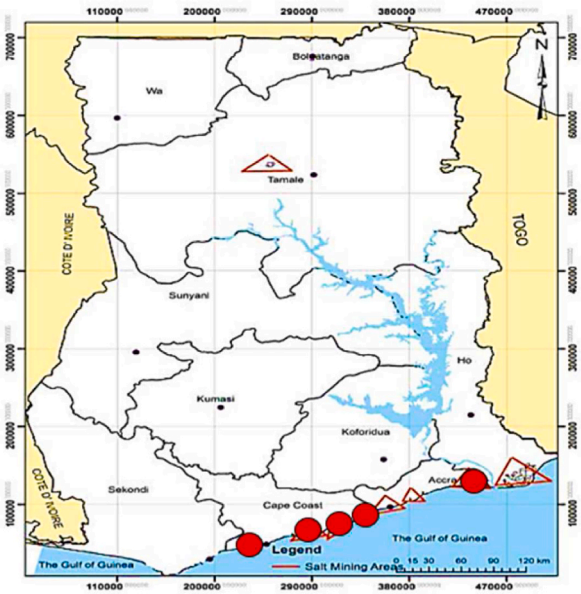

Fig. 1. Map of Ghana showing selected salt producing sites in Greater Accra and Central regions, with sampling sites marked by red circles (Source: Atta-Quayson, 2018). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 1
Demographic characteristics artisanal salt producers and their awareness of iodine deficiency.

Demographic characteristics	Frequency		Awareness of Iodine Deficiency (yes)	
	n (166)	%	n (82)	%
Gender				
Female	36	21.7	13	15.9
Male	130	78.3	69	84.1
Age of Respondence				
<20	3	1.8	1	1.2
20–29	27	16.3	11	13.4
30–39	33	19.9	17	20.7
40–49	50	30.1	26	31.7
50–59	26	15.7	14	17.1
> 59	27	16.3	13	15.9
Educational level				
Basic	90	54.2	38	46.3
Secondary	39	23.5	24	29.3
Tertiary	13	7.8	12	14.6
None	24	14.5	8	9.8
Year of Experience in salt production				
0–19	102	61.5	51	62.2
20–40	60	36.1	29	35.4
>40	4	2.4	2	2.4
District				
Ada West	80	48.19	41	50.0
Gomoa East (kasoa)	22	13.25	11	13.4
Gomoa West (apam)	16	9.64	4	4.9
Komenda Edina Eguafo Abirem	2	1.20	1	1.2
Ningo/Prampram	5	3.01	3	3.7
Winneba	41	24.70	22	26.8

3.2. Awareness of salt iodization and iodine deficiency

Most artisanal salt producers interviewed were conversant with the term, salt iodization (93.98 %). Majority of these respondents alluded to hearing the term for the first time from colleague artisanal salt producers or the community (51.25 %), and electronic media (i.e., radio, TV programmes and advertisements, 38.75 %). 10 % heard salt iodization for the first time at training workshops organised by salt producers' associations in collaboration with government and international agencies e.g., FDA, Minerals Commission and UNICEF (Fig. 2). 50.60 % of the artisanal salt producers were not conversant with iodine deficiency (ID) and 49.40 % were conversant with the term. Out of the 49.40 % respondents conversant ID, majority (i.e., 65.82 %) had good knowledge of ID and effective measures

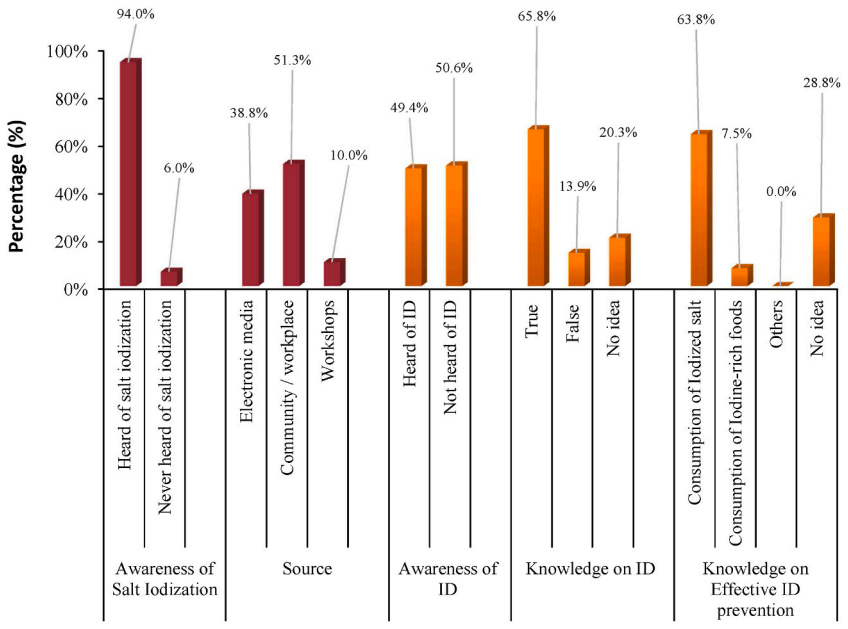

Fig. 2. Respondents' awareness of salt iodization, and knowledge on ID.

for its prevention. Majority of these respondents indicated consumption of iodized salt (63.75 %) and iodine – rich foods (7.50 %) as the preventive measures for ID (Fig. 2)

3.3. Knowledge on salt iodization

Some of the artisanal producers (36.75 %) interviewed cited prevention of Iodine Deficiency Disorders (IDDs) and promotion of good health (29.52 %) as the reason for iodizing edible salt. However, 10.24 % of respondents iodize salt for reasons other than prevention of IDDs and promotion of good health. These reasons included to kill microorganisms in saline water in concentration pans, to hasten crystallization of salt from saline water in concentration pans, to remove impurities from crystallized salt and to avoid arrests and harassments by some personnel of the Ghana Police Service. These responses collectively suggest a lack of knowledge on relevance of salt iodization amongst 10.24 % of artisanal salt producers interviewed. 23.49 % of respondents had no knowledge on the relevance of iodizing salt. All the artisanal salt producers interviewed did not have knowledge on recommended concentration of iodine in iodized salt at the point of production.

3.4. Salt production practices

All artisanal salt producers interviewed utilise the solar evaporation method for salt production. Several pans are dugout, however each production unit comprises a minimum of three pans i.e. two concentration pans and a crystallization pan (see Fig. 3a and 3b). Two types of pans were observed at the sites; tarpaulin/polyethylene lined pans and concrete pans. Tarpaulin/polyethylene lined pans were predominantly used in Greater Accra, and concrete pans in Central region.

The salt production process entailed filling of pans with salty water either from the sea, lagoon or dug out wells. Salt crystallization is achieved naturally through solar evaporation. Crystallized salt is then harvested manually using plastic baskets and heaped on the bare floor, in the sun to dry. Dried salt is bagged into jute sacks and sold/stored.

Majority (60.84 %) of salt producers indicated their salt had a coarse texture, with 33.73 % having a granular texture. The main quality checks conducted on salt after harvest included colour check, hardiness and presence of particulate matter in the salt mass. Majority (64.36 %) of the respondents alluded to checking colour of the salt. According to respondents, the colour gives an indication of level of dirt in the salt. An off-white colour indicates presence of dirt. They also mentioned that salt that has an off-white colour is washed in the brine or sold to market women who engage in traditional fish preparations e.g., koobi and momoni. Salt is package in jute sacks of varying weight after production (i.e., 25 kg, 50 kg and 75 kg). Most of these sacks were salt producers' association branded sacks bearing the inscription, iodized salt. Particularly in Central region, where salt is not iodized due to unavailability of iodine, this amounts to consumer deception. All packaged salts are conveyed to the markets in open trucks.

Majority (69.28 %) of artisanal producers do not iodize salt produced whilst 6.05 % iodize salt occasionally. The 24.70 % of producers iodize their salt during production and they were mainly artisanal producers in Ada West and Ningo/Prampram districts. Majority (90.74 %) of salt producers had no knowledge of the iodizing agent used. All producers iodizing their salt, alluded to sourcing the iodizing agent (potassium iodate) from open market.

3.5. Production challenges

According to the artisanal salt producers, the major challenges confronting artisanal salt production are, weather (60.57 %), production/marketing issues (24 %), business competition (8.70 %) and iodine unavailability (4 %). According to the producers, salt production is greatly hampered during the rainy season. This was mainly due to two reason i.e. dilution of salty water in pans which delay crystallization and salt harvest, and overflow of lagoon banks which leads to filling of pans with lagoon water and sand deposits which often destroy the concrete pans (exclusively Central region respondents). Bad road networks, shortage of lagoon water, difficulty pumping salty water from lagoon/dugouts into pans and defecation around pans were some of the production issues encountered by the producers.

Fig. 3a. Tarpaulin lined crystallization pans in Ada West district, i.e., Songhor site, Dec 2022.

Fig. 3b. Concrete crystallization pans in KEEA, i.e., Elmina site, Dec 2022.

3.6. Salt iodization practices

Majority (69.28 %) of artisanal producers do not iodize salt produced. These artisanal producers were mainly located in Ada West and Ningo/Prampram districts. 6.05 % iodize salt occasionally (Fig. 4). Some of the reason indicate for not iodizing the salt were unavailability of iodine (55.29 %) and safety/quality concerns with iodine (24.71 %). Most (90.74 %) of salt producers had no knowledge of the iodizing agent used. According to 7.41 % and 1.85 % of the producers, potassium iodate and potassium iodide are used respectively. All producers iodizing their salt, alluded to sourcing the iodizing agent from open market.

4. Discussions

The individual/demographic characteristics of the artisanal salt producers explored were age, gender, district, educational background and number of years of experience spent in salt production. The results showed that majority of the artisanal salt producers were male and were of the ages of 20 years and above. Most of them had basic (54 %) or secondary (23 %) education. The trend in educational background among artisanal salt producers is similar to that observed during the 2021 population census in Ghana, which show 41 % and 21 % of the population had attended, in the past, basic and secondary education respectively [14].

The production process of salt by the artisanal producers is similar to the process employed by salt producers in other countries such as Senegal and Tanzania [15–17]. Salt producers in these countries also uses the solar evaporation of seawater in the process of salt production. Challenges encountered by the artisanal salt producers is similar to challenges describes in studies conducted on challenges encountered by salt producers in other geographical locations [18–21]. These challenges include seasonal weather changes, lack of storage facilities, poor road network and availability of ready market.

Almost all the artisanal salt producers knew about the salt iodation in Ghana and had adequate knowledge on IDDs and the need to

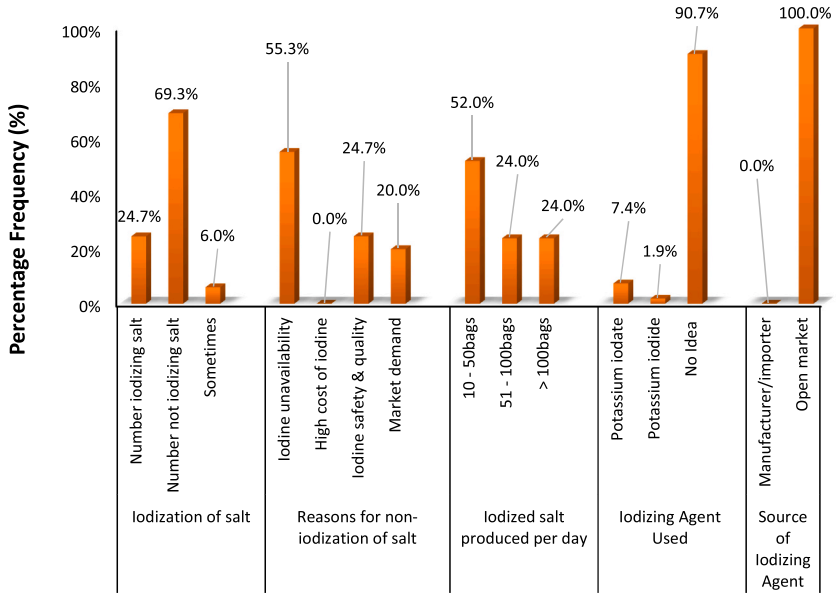

Fig. 4. Salt iodization practices amongst artisanal salt producers.

iodized salt to prevent it and promote health. Various studies have correlated adequate knowledge with good practices [22–24]. However, this study observed otherwise with the artisanal salt producers. Even though majority of the artisanal salt producers new about IDDs, its health benefits and provisions of the law on salt iodization in Ghana, they were still not iodizing the salt during production. They attributed their inability to iodize the salt during production to the cost of Potassium iodate on the market and its availability.

If this trend is not addressed, the objectives of the universal salt iodization program will not be achieved [12,13]. Artisanal salt producers contribute to about 70 % of salt production on the Ghanaian market and their practice affect the universal salt iodization programme in Ghana. These negative practices of the artisanal salt producer could account for the low availability and utilization of iodized salt in Ghana as observed in studies conducted [13,25–28]. However, in countries that salt producers adhere adequately to the salt iodization practices, availability of iodized salt on the market and its utilization is high [26,29–32]. Some studies have also recommended strict enforcement and monitoring of adherence to requirements of the salt iodization in Ghana, as a strategy to improve availability and utilization of iodized salt [33,34].

To increase adherence to salt iodization requirements and improve availability and utilization of iodized salt, regulatory authorities need to enforce the provisions of the law and requirements on salt iodization in Ghana. Since these strategies have worked in other countries [35–37]. The Government also need to create the enabling environment for artisanal salt producer to have access to potassium iodate for production. This will reduce the challenges encountered by the artisanal salt producers in obtaining potassium iodate for production and also encourage them to iodized their salt during production.

5. Conclusion

The artisanal salt producers utilise the solar evaporation method for salt production. Two types of pans were used by the artisanal salt producers at the sites: tarpaulin/polyethylene lined pans and concrete pans. Tarpaulin/polyethylene lined pans were predominantly used in Greater Accra, and concrete pans in Central region. Even though the artisanal salt producers were conversant with salt iodization and had fair knowledge on the health effects of iodine, majority of these artisanal salt producers do not iodize their salt during production.

The Government need to create the enabling environment for artisanal salt producer to have access to potassium iodate for production and then enforce the laws on salt iodization if it intends to achieve the objectives of the Universal Salt Iodization programme in Ghana.

Funding statement

This research was funded by the Food and Drugs Authority of Ghana.

Ethics approval and consent to participate

Informed consent of participants was obtained by Food and Drugs Authority (FDA) prior to the collection of data, as part of its regulatory activities. The data collection process was done in accordance with all regulatory and ethical guidelines. Ethics approval was not necessary as this study involved the use of a de-identified data obtain as part of data collected by the Food and Drugs Authority (FDA) during their Post Market Surveillance activities. All the required approvals for the use of data were obtained from the Chief Executive Officer of FDA, Ghana.

Data availability

Data associated with this study is not deposited in any publicly available repository. The data used in this research work will be made available upon formal request to the Chief Executive Officer of FDA, Ghana.

CRediT authorship contribution statement

Benjamin Osei Tutu: Writing – original draft, Supervision, Formal analysis, Data curation, Conceptualization. **Bella Rosaling Nkansah:** Writing – review & editing, Project administration, Methodology, Investigation, Conceptualization. **Nana Akua Serwaa Yeboah:** Writing – review & editing, Supervision, Project administration. **Faustina Atupra:** Writing – review & editing, Validation, Resources. **Roderick Kwabena Daddey-Adjei:** Writing – review & editing, Supervision, Funding acquisition. **Delese A.A. Darko:** Writing – review & editing, Resources, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e29621.

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