BC Centre for Disease Control
An agency of the Provincial Health Services Authority

Environmental Health Services

Food Issue

Notes from the Field

Risk assessment of sea salt production from marine waters

Request received from:	Vancouver Island Health Authority
Date of request:	June 19, 2015
Issue *(brief description)*:	Are there any hazards with producing sea salt through evaporation of salt water? Water is collected from ocean along east coast of Vancouver Island. Evaluate results of sea salt testing.

Summary of search information

1. Internet sources: Google "heavy metal contamination" or "manufacture" AND "sea salt". Very few good references, some manufacturing info and blog sites.
2. Ovid (define your search terms): FSTA and CAB: "sea salt" AND "contamination" AND "food safety". FSTA, 40 hits, one of interest. CAB, 35 hits, 2 of interest (one same). PubMED: "sea salt" AND "contamination", 17 hits, none of interest. Salt manufacture not listed in Encyclopedia of Food Sciences & Nutrition.
3. Consulted 8-1-1 dial-a-dietician, and M. Wiens (Information Specialist).

Background information

Sea salt is manufactured using a variety of methods. Salt can be scraped off of evaporation ponds in warm dry climates, or sea water can be processed by boiling or filtering to render a crystalline product.[1]

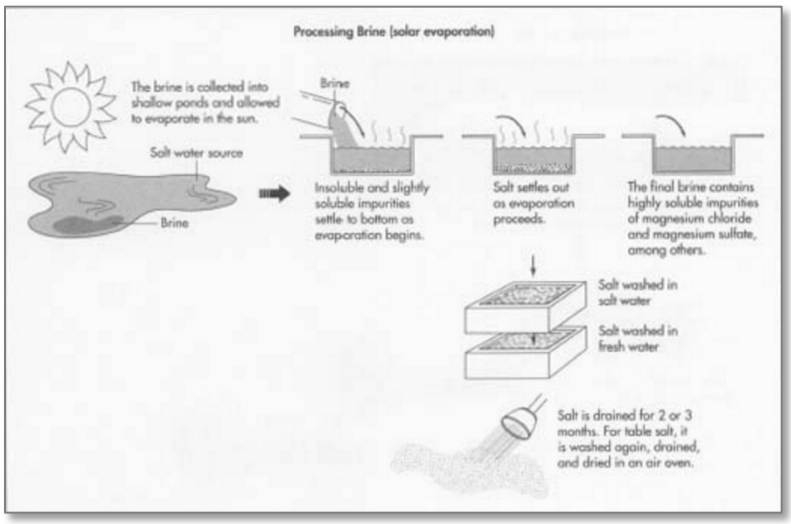

Figure 1 – obtained from *Salt – how products are made*. http://www.madehow.com/Volume-2/Salt.html

Salt is either obtained from brine (sea or salt water) or from mining of rock salt (halite).[1] In hot climates such as Portugal, "Salinas" are documented as early as the 9th century, and involve a series of supply ponds, evaporation ponds and crystallizer ponds.[2] In this system, the ecology of organisms living in the ponds can affect the quality and production of the sea salt.[2] Ecological concerns with salt mining can include concentration of trace metals in sediments (Cd, Co, Cu, Mn, Ni, Pb, Zn, and Fe) that may be harmful to animals living in the area.[3] Brines often contain other dissolved minerals. During evaporation, insoluble impurities such as sand or clay will settle out, or they can be removed by filtration. Evaporated brines containing soluble impurities can be removed through mechanically removing salt that has precipitated before evaporation is complete. In northern climates such as Canada and the UK sea water must be boiled to evaporate and remove most of the water before the salt can be precipitated. It would be important at this stage to remove salt before complete evaporation to leave behind any soluble impurities.

Proponents of sea salt claim trace minerals left in sea salt are beneficial, and that bleaching and refining of free-flowing table salt remove these nutrients.[4]

What are the risks associated with sea salt manufacture

After an extensive literature search, very few articles could be found that inferred hazards for sea salt. In one Korean paper, heavy metals were detected in mudflat solar salt mixtures. The highest levels detected were 0.5ppm for arsenic, 0 .1 ppm for cadmium, 4.8 ppm for copper, and ~0.2 ppm for lead and mercury.[5] The author claimed none of these levels were above permitted limits. In another Korean paper, dioxins and dibenzofurans were also measured in samples of baked sea salts.[6] On the Spanish Mediterranean coast organic pollutants such as plasticizers and fragrances, organophosphorus pesticides, herbicides and urban and industrial pollutants (caffeine, butylated toluenes and others) were found in marine salt samples collected in saltworks.[7,8] One company blog site asserted issues with sea salt harvested in France and the presence of lead, indicating that presence of these metals may also be of concern in other areas, dependant on the site and history.[9]

What metals and chemicals are of concern in foods? The Canadian Food Inspection Agency (CFIA) issued a report summarizing results of chemical monitoring in foods. In this report metals of importance to toxicological health included arsenic (As), mercury (Hg), cadmium (Cd), and lead (Pb).[10] They also acknowledge that very few minimum residue limits (MRLs) have been established for foods.[10] Health Canada, under B.01.046 of the Food and Drug Regulations (FDR) also prohibits any amount of chlorinated dibenzo p-dioxins in foods, these chemicals are considered adulterants.[11]

Guidance on sea salt from Health Canada and CFIA and other regulatory authorities

Values to consider for As, Cd, Hg and Pb metals. As no standard for sea salt exist as a food commodity, estimates were established from MRLs for other food products. The MRLs for two of the four metals can be found in Table 1, Division 15 of the FDR. MRLs for As range from 0.1ppm in fruit juice to 3.5ppm in fish protein, for Pb from 0.08 ppm in infant formula to 10ppm in edible bone meal, and no values for Cd

or Hg were reported.[11] Values for Hg do exist for fish, they range from 0.5ppm in retail fish to 1ppm in tuna, shark, and other fish.[12] Values for Cd are established as an export requirement for shellfish, and range from 1ppm to 2ppm.[13]

Sea salt is exempt from the requirement to contain iodine (Section 17 of Food and Drugs Act),[14] according to the CFIA. Their web-site information about sea salt is somewhat ambiguous, two opposing statements about sea salt claim it "must meet prescribed standard for salt" and "do not have to meet the standard for salt". This appears to be related to labelling and the allowable absence of iodine from sea salt. As long as the sea salt is not labelled for table or general household use, it is acceptable. No minimum residue limits for chemicals are given, and other mineral salts are expected in the sea salt product.[15] Requirements for regular free-flowing table salt are found in Table 1 of B.16.100 of Health Canada's Food and Drug Regulations.[11]

Previous guidance on sea salt manufacture or use of marine waters from British Columbia

No previous guidance on processing of salt or sea salt has been given. However, previous advice on use of marine water for commercial tanks, and advice on harvesting of bull kelp has been given in the past. These included harvesting (marine plants or water) from open approved areas according to shellfish harvesting standards, harvesting away from sewage or storm water outfalls, and compliance with all necessary regulations. Guidance pertinent to this issue is summarized below.

Assessment of the recipe and laboratory results provided for this product

A review of the recipe and laboratory report (shown in the Appendix) finds the sea salt method and lab results acceptable. A detailed analysis and description is given below.

After collection of water, it is filtered prior to evaporation by boiling. Filtration will remove insoluble components such as sand. Skimming of the salt crystals before the water is completely evaporated will also increase purity of the sea salt by limiting soluble impurities, such as magnesium chloride. The proposed method is acceptable.

The laboratory report declares no Cd, As, or Pb was found. A further report (not sent to us) indicated Hg was also not detected. The "RDL" value is likely the reported detection limit, and was also assessed. The RDL for As appears to be higher than the detectable limit of MRL food values reported in the CFIA report. The RDL was given as 10 µg/g (i.e. 10 ppm) for As, 3 ppm for Pb, and 1ppm for Cd. The results for Pb and Cd appear acceptable. Given the RDL for As is 10 ppm, would a hypothetical value (non-detectable) of 9 ppm be unacceptable? Since very little salt is used, estimate 3000 mg per adult per day, what is the oral MRL for As? Chronic exposure levels have been set by the Food and Drug Administration at 0.003 mg of As/kg/day for a 55 kg adult.[16] If As was present in the salt at 9 ppm (equivalent to 0.009 mg/g), given an adult may consume approximately 3 g of salt per day, the max. amount of As ingested would be 0.027 mg total, equivalent to ~0.0005 As/kg/day for a 55 kg adult. Therefore, as this value is 10X less than the acceptable MRL for chronic exposure to As we can assume the negative value given in the lab report is also acceptable.

Regarding other chemicals found in the report, only a value for magnesium (Mg) was found. Magnesium is an essential nutrient for the body.[17] A value of 13,000 µg/g was found for Mg. Mg recommended values for daily intake range from 310 mg (women) to 420 mg (men).[18] Again assuming 3g salt consumption, the maximum amount of Mg obtained from the sea salt would be 39 mg, approximately 10x lower than the recommended daily limit. This is acceptable.

Recommendations from BCCDC

Based on previous recommendations the following guidance is provided for the manufacture of sea salt.

- Sea salt sold in farmers' markets or elsewhere must comply with all provincial and federal labelling requirements, including
  - Not representing the item as for table or household use
- Sea salt water should not be harvested from areas where
  - Industrial activities are known to have occurred that may have contaminated the area with toxic heavy metals or pollution sources (persistant organic pollutants).
  - Closures for shellfish harvesting for marine biotoxin or sanitary closures are in effect. This information will assist the operator in fulfilling this recommendation:
    - Fisheries and Oceans Canada is responsible for enacting the opening and closing of shellfish areas.
      - The official site for Marine Biotoxin Updates remains the DFO Website at: http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/biotox/index-eng.htm
      - You may apply to receive fishery notices by email from DFO at the following link: http://www-ops2.pac.dfo-mpo.gc.ca/fns_reg/index.cfm

  The rationale for this is that many marine biotoxins and persistent organic pollutants are not destroyed by boiling.
- Sea salt water is further not recommended to be harvested from areas where
  - Sewage outflows or combined sewerage/stormwater outflows exist to limit exposure of plant materials to enteric pathogens. Harvest sites should be at least 300 metres away from open sewage or storm-water outflows.

  Although microbes are destroyed by boiling, the potential for cross contamination within a kitchen home or commercial kitchen when dealing with large quantities of polluted water constitutes an avoidable risk.

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Appendix – Recipe and Laboratory Result

Recipe

The process for their sea salt production is:

- Collection from the sea at high tide.
- Filtering through deep-fryer filters.
- Boiling for about 8 hours (reduced from 80 L to 10L during that time frame).
- Skimming the salt crystals, drying, adding aromatics, packing.

Laboratory Report

RESULTS OF ANALYSES OF FOOD

Maxxam ID		AKS124	
Sampling Date		2015/06/03	
	Units	**CLEVER CROW "PURE SEA SALT"**	**RDL**
Metals			
Acid Extractable Arsenic (As)	ug/g	ND	10
Acid Extractable Barium (Ba)	ug/g	ND	30
Acid Extractable Boron (B)	ug/g	ND	50
Acid Extractable Cadmium (Cd)	ug/g	ND	1
Acid Extractable Calcium (Ca)	ug/g	ND	5000
Acid Extractable Chromium (Cr)	ug/g	ND	30
Acid Extractable Cobalt (Co)	ug/g	ND	0.5
Acid Extractable Copper (Cu)	ug/g	ND	50
Acid Extractable Iron (Fe)	ug/g	ND	300
Acid Extractable Lead (Pb)	ug/g	ND	3
Acid Extractable Magnesium (Mg)	ug/g	13000	10000
Acid Extractable Manganese (Mn)	ug/g	ND	30
Acid Extractable Molybdenum (Mo)	ug/g	ND	5
Acid Extractable Nickel (Ni)	ug/g	ND	5
Acid Extractable Selenium (Se)	ug/g	ND	10
Acid Extractable Sodium (Na)	ug/g	320000	5000
Acid Extractable Tin (Sn)	ug/g	ND	30
Acid Extractable Titanium (Ti)	ug/g	ND	50
Acid Extractable Zinc (Zn)	ug/g	ND	200

ND = Not detected
RDL = Reportable Detection Limit