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# Importance of Monitoring and Criteria for a Possible Classification According to Sources and Specific Chemical Compositions of Food Grade Salt

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ABSTRACT

Public awareness of general health and human nutrition, which favours the dissemination of national and international standards or guidelines for many foodstuffs including food grade salt, should be taken into consideration step by step. The evolution of salt consumption is reviewed and the necessity for salt manufacturers to achieve the proper quality of salt is discussed. Examples of monitoring by simple process controls in the Italian Monopoly's food grade salt plants are reported. In addition, on the basis of the results of surveys carried out, the possibility of classifying food grade salt according to sources and specific average chemical compositions is proposed. The average composition and contents of some essential trace elements determined in the food grade salt produced by Italian Monopoly are reported.

## INTRODUCTION

Recently, widespread public interest in a better quality of life related to health has created a growing concern about the characteristics of foods in our daily diet. The increased consumption of new processed foods has favoured the spreading of incorrect statements on the healthiness or harmfulness of the various foods. In order to remove any prejudices and misinformation and to protect public health, the Italian authorities took action, by issuing rules or guidelines. The widespread use of edible salt has also called the attention of the Health Authorities to its requirements; domestic and international salt standards have been or are being issued.

### Evolution of consumption

Salt has been used as a food or ingredient in foods since primordial times; anthropological data show that the taste for salt and its widespread use developed as culture progressed and are strictly related to the progress of man (Kaufmann, 1960). Chinese, Greeks and Romans used it as food and to preserve fish and meat; it was also largely used as a medicinal principle. For its applications it was a religious symbol of wisdom and prosperity among the Orientals. Romans, Greeks and Egyptians used it as money in trade; today's "salaries" are the direct descendants of the salt given as wages to the Roman legionaries.

The first known salt mines were found in the Austrian Tyrol and date back to the late Bronze Age. In Italy the oldest solar salt-works, at Margherita di Savoia near Foggia, probably dates back to the fifth century B.C.; it was certainly operated by the Greeks and provided Romans with almost all their requirement of salt. At Volterra, near Pisa, there is the oldest Italian salt of mineral origin. The Etruscans were the first to exploit the natural salt springs pouring out to the surface. In the following centuries the brine wells were considered among the main riches in the area and for this reason were always contested. Already at the beginning of the 18th century Florence had reserved salt for industry; salt was the raw material which mostly contributed to the public treasury.

The methods of salt recovery have varied very little with time. It has only been during this century, mainly in industrialized countries, that a new product has been obtained with the development of new evaporation and mining techniques; as well as by the addition of compounds which improve salt quality and favour the consumers' use.

It is difficult to determine the actual figures of dietary salt intake; long and complex studies on the nutritional habits of large population samples in the various countries would be necessary. Salt intake varies throughout the world according to differences in the climate and in the dietetic habits. On the basis of information supplied by the governments during the preparation of the International Standard for food grade salt within the Codex Almentarius Commission of FAO/WHO (1982, 1985), the total dietary salt consumption was estimated around 10–12 g/day per capita.

It is a fact, however, that a negative trend is prevailing in the food grade salt market: its consumption has not kept up with population growth. According to data collected by the European Committee for the Study of Salt (ECSS, 1989) the sales of food grade salt, amounting to about 2.5 Mt in the years 1980–83, decreased in 1984 to 2.2 Mt, remaining steady thereafter. Such lower consumption is due to various factors, but mainly to the development of food preservation through deep-freezing and of new technologies in food industry; besides, following urbanization, the diet has changed and the consumption of processed foods with low salt content has increased. Anti-salt campaigns aimed at the prevention and control of hypertension have also adversely affected the intake of table salt. The dietary salt market in Italy shows trends similar to those in the other EEC member states.

Within this frame and despite the past social and economic importance of food grade salt, quality assurance has become a necessity for any salt manufacturer wishing to retain a competitive position in the market.

## QUALITY ASSURANCE BY PROCESS CONTROL

Generally, quality is defined as the degree of fulfilment of the consumer's requirements by a product's characteristics. In no other market is the quality of the product so essential as in the food market; a company's losses and gains are strictly tied to the needs of consumers who are nowadays more than ever well informed and able to compare the different performances of the products and their quality as they perceive it. For any food manufacturer quality means to produce while keeping to the budget and the specifications. Such specifications concern not only the requirements of any commodity, but also specific regulations.

### Inspection and control

The specifications established by the health authorities are usually the minimum for a safe food product; no departures are admitted. Legal controls carried out by inspecting the product already on the market make no allowances for an acceptable risk of there being a proportion of faulty products. The product is either accepted of rejected.

Manufacturers' controls are different, both in purpose and in performance. If a food producer only inspected the finished product at his site, this control would be belated. The rejects could be so many as to weigh excessively upon the cost of an acceptable quality product and corrective measures could no longer be applied. Food quality must be assured by the preventive control of the regularity of the processes. If the manufacturing process is monitored continuously, timely corrective actions are possible if necessary and either all the product quality will be acceptable or at least the quantity of rejects will be negligible.

This is especially true in the case of food grade salt, a product usually defined as "poor" because of its low market price. Due to the possibility of a minimum value added to the production cost, the necessity of always producing acceptable quality salt should not lead to excessive controls during processing, as these would be equally burdensome from the economic point of view.

### Process control feasibility

It is possible to plan the most convenient control for evaluating the significant variables that mainly influence the salt quality in the specific process; then, having identified the dominant element in the manufacture, the production cycle is divided into elementary stages and analyzed; the monitoring can be limited to specific points acknowledged as critical. As usually happens for other food industries and also in the case of the food grade salt production, the composition characteristics are the prevailing significant variables. The product quality is essentially affected by the composition of the raw material and by any modification during manufacture.

The essential characteristics for food grade salt are the contents of: sodium chloride; secondary compounds, both major and trace; and any additives or residues of technological aids. Few of these are interrelated (e.g. the contents of sodium chloride and major secondary compounds). All of them are physiochemical quantities and can be controlled by evaluating typical indexes directly referred to measured values. The difference in the sources (underground deposits, seawater, natural brines), in the raw materials (brines, raw crystals) and in the processes used, both for the mining or the crystallization and during any other later stage, can influence in a totally different way the final quality of the salt produced. The various possibilities only allow the identification of the main critical points of any process in a general way. In order to be able to point them out in detail it is necessary for each and every production cycle to be individually analyzed.

In order to implement its Quality Assurance Program, Italian Monopoly planned some simple process controls at its own factories. Here we report, for example, those provided for the operations of refined salt recovered from both seawater and artificial well brines. For the analytical determinations ISO and ECSS methods of analysis were used, when applicable, together with other colorimetric and atomic absorption spectrometric methods suitably developed.

## AMMINISTRAZIONE DEI MONOPOLI DI STATO'S PROCESS CONTROLS IN SALT MANUFACTURING

Salt is produced by Amministrazione dei Monopoli di Stato on the basis of seasonal cycles at the solar salt-works of Margherita di Savoia, Cagliari with its branches at S. Antioco and Carloforte, Cervia, and Tarquinia, a branch of Volterra. In addition, artificial brines obtained by the dissolution of underground rock salt deposits are continuously evaporated with the thermo-compression plant at the salt-works of Volterra. In the last five years, the average annual production of solar salt and evaporated salt amounted to about 600,000 and 85,000 t, respectively. The output of directly processed food grade salt is about 100,000 t/year (Ministero Finanze, 1985–89).

### Refined solar salt

The production cycle of refined solar salt for food uses includes crude salt washing, centrifugation, drying, screening and packaging. Through the screening the kind of salt is determined and therefore the name under which it is put on the market. Typical grain-size ranges of the salt packaged for direct sale to consumers are 1.25–8 mm (coarse salt) and 0.25–0.7 mm (fine salt). The cycle analysis made clear that the main critical points to be controlled are the crude salt (a raw material which is not yet a foodstuff), the washing stage and the salt before the packaging stage.

#### *First critical step*

The composition of the crude product as harvested from the ponds and piled up in the various salt-works is analytically controlled. Significant variables for the production of food grade salt are considered: the sodium chloride content on a dry basis (estimated by determining the major secondary components' concentration), the lead, cadmium, copper, arsenic and mercury contents (for which limits were set in the International Standard) (FAO/WHO, 1986) and the contents of other potentially harmful trace components. In order to check as reliably as possible the suitability of the harvested product for the later production of food grade salt or for a different use, a minimum total quantity of samples is taken in a percent ratio of about $1 \times 10^{-4}$ to the total crop, immediately upon stockpiling. Reduced representative samples, divided according to the piling period, the pond area of origin, the storage yard (if more than one) and the position on the stockpile, are analyzed. The results of the analyses carried out in the various salt-works from 1980 to 1989 (Table 1) show that all the crude salts produced have potentially toxic component contents which are already appreciably lower than the limits fixed by the International Standard. Only in the case of lead, concentration ranges with maximum values equal to 1.5 and 2.0 mg/kg were found in some salt-works. Although the fixed limit was not exceeded, the dispersion and the frequency distribution of the measured values led Italian Monopoly not to use crude salt with a higher lead content than 0.7 mg/kg for food grade salt manufacturing. Such maximum value was established taking into account the process procedure and on the basis of statistical estimates, having considered an acceptable risk that in 0.9% of the crude salt, there could be higher contents. It is to be noted that the minimum NaCl content can be lower than 97% wt. (dry basis), due to the considerable bittern content resulting from the sampling procedure itself. The only subsequent draining of the salt in the stock-pile allows NaCl contents to be higher than 97%.

Current food grade salt manufacturing uses the crude products of Margherita di Savoia and Cervia (Table 2). The refined solar salt, coarse and fine, is produced exclusively with crude salt from Margherita di Savoia; it is manufactured both in the same salt-works and in three processing factories at Tortona, Porto Marghera and Castellammare di Stabia.

#### *Second critical step*

Considering the characteristics of the different plants, it was established that it is sufficient to control the density and the suspended matter content in the wash brine from the settling tank, in order to limit both salt losses during the process and insoluble matter contents in the finished product.

#### *Third critical step*

As washing operations were found to lower the contents of potentially harmful compounds, only two

TABLE 1

Crude solar salt composition. Undrained samples, drawn during harvesting

| | | | Margherita di Savoia | Cagliari | S. Antioco | Cervia | Tarquinia |
|---|---|---|---|---|---|---|---|
| Loss on drying at 110°C | | % | 5.5–14.5 | 4.5–9.0 | 4.5–10.0 | 3.5–7.0 | 5.0–9.0 |
| Figures expressed on a dry basis | | | | | | | |
| Sodium chloride | NaCl | % | 94.0–97.5 | 96.5–97.5 | 96.7–98.4 | 97.5–98.5 | 96.5–98.3 |
| Calcium | Ca | % | <0.10–0.30 | <0.10–0.25 | ≤1.10 | <0.10–0.20 | ≤0.10 |
| Magnesium | Mg | % | 0.30–1.19 | 0.25–0.60 | <0.10–0.34 | 0.13–0.37 | <0.10–0.35 |
| Potassium | K | % | 0.10–0.34 | 0.10–0.20 | <0.05–0.15 | 0.06–0.09 | <0.05–0.09 |
| Sulphates | $SO_4$ | % | 0.72–2.30 | 0.93–1.24 | 0.30–0.90 | 0.35–0.85 | 0.30–0.70 |
| Matter insoluble in water | | % | <0.10–0.25 | <0.10–0.20 | <0.10–0.25 | <0.10–0.20 | <0.10–0.40 |
| Copper | Cu | mg/kg | <0.05–0.45 | <0.05–0.20 | <0.05–0.45 | <0.05–0.50 | <0.05–0.25 |
| Lead | Pb | mg/kg | <0.1–0.6 | <0.1–1.5 | <0.1–2.0 | <0.1–0.7 | <0.7–1.5 |
| Cadmium | Cd | mg/kg | <0.01* | <0.01* | <0.01* | <0.01* | <0.01* |
| Mercury | Hg | mg/kg | <0.005* | <0.005* | <0.005* | <0.005* | <0.005* |
| Arsenic | As | mg/kg | <0.03* | <0.03* | <0.03* | <0.03* | <0.03* |
| Ammonia | $NH_3$ | mg/kg | 3–16 | 3–10 | 3–25 | 2–10 | 3–10 |
| Nitrates | $NO_3$ | mg/kg | ≤2.0 | ≤2.0 | <2.0–5.5 | <2.0–3.0 | ≤2.0 |
| Nitrites | $NO_2$ | mg/kg | <0.2–0.5 | 0.4–0.9 | <0.2–0.7 | <0.2–0.6 | <0.2–0.7 |
| Phosphates | $PO_4$ | mg/kg | 1.0–5.0 | 1.0–5.0 | 1.0–6.0 | 4.0–6.0 | 1.0–6.0 |
| Boron compounds | B | mg/kg | 2–30 | 6–17 | <1–15 | 2–20 | 2–8 |

*Limit of determination.

TABLE 2

Seasoned crude solar salt composition

| | | | Margherita di Savoia | Cervia |
|---|---|---|---|---|
| Loss on drying at 110°C | | % | 2.0–4.5 | 3.0–5.5 |
| Figures expressed on a dry basis: | | | | |
| Sodium chloride | NaCl | % | 97.0–99.0 | 98.0–99.0 |
| Calcium | Ca | % | 0.10–0.20 | 0.10–0.20 |
| Magnesium | Mg | % | <0.10–0.35 | 0.18–0.27 |
| Potassium | K | % | 0.02–0.13 | 0.06–0.09 |
| Sulphate | $SO_4$ | % | 0.30–0.90 | 0.35–0.85 |
| Matter insoluble in water | | % | <0.10–0.25 | <0.10–0.15 |
| Copper | Cu | mg/kg | <0.05–0.20 | <0.10–0.20 |
| Lead | Pb | mg/kg | <0.1–0.2 | <0.1–0.4 |
| Cadmium | Cd | mg/kg | <0.01* | <0.01* |
| Mercury | Hg | mg/kg | <0.005* | <0.005* |
| Arsenic | As | mg/kg | <0.03* | <0.03* |
| Ammonia | $NH_3$ | mg/kg | 3–10 | 3–10 |
| Nitrates | $NO_3$ | mg/kg | ≤2.0 | <2.0–3.0 |
| Nitrites | $NO_2$ | mg/kg | <0.2–0.5 | <0.2–0.6 |
| Phosphates | $PO_4$ | mg/kg | 1.0–2.0 | 5.0–6.0 |
| Boron compounds | B | mg/kg | 5–15 | 10–15 |

*Limit of determination.

TABLE 3

Refined solar salt composition

| | | | Margherita di Savoia | Tortona | Porto Marghera | Castellammare di Stabia |
|---|---|---|---|---|---|---|
| Loss on drying at 110°C | | % | <0.2–0.5 | <0.2–0.8 | <0.2–0.6 | <0.2–0.5 |
| Figures expressed on a dry basis: | | | | | | |
| Sodium chloride | NaCl | % | 99.3–99.7 | 99.1–99.7 | 99.2–99.6 | 99.4–99.5 |
| Calcium | Ca | % | <0.05–0.10 | <0.05–0.09 | <0.05–0.08 | <0.05–0.10 |
| Magnesium | Mg | % | <0.04–0.09 | <0.04–0.08 | <0.04–0.08 | <0.04–0.08 |
| Potassium | K | % | <0.02–0.05 | <0.02–0.05 | <0.02–0.04 | <0.02–0.04 |
| Sulphates | $SO_4$ | % | <0.20–0.40 | <0.20–0.32 | <0.20–0.38 | <0.20–0.36 |
| Matter insoluble in water | | % | <0.01–0.07 | <0.01–0.10 | <0.01–0.10 | <0.01–0.08 |
| Copper | Cu | mg/kg | ≤0.05 | ≤0.05 | ≤0.05 | ≤0.05 |
| Lead | Pb | mg/kg | ≤0.1 | ≤0.1 | ≤0.1 | ≤0.1 |
| Cadmium | Cd | mg/kg | <0.01* | <0.01* | <0.01* | <0.01* |
| Mercury | Hg | mg/kg | <0.005* | <0.005* | <0.005* | <0.005* |
| Arsenic | As | mg/kg | <0.03* | <0.03* | <0.03* | <0.03* |

*Limit of determination.

indicators — moisture and grain size — are checked in the salt before packaging.

The results of subsequent statistical controls (Table 3), carried out by analyzing a representative sub-sample of the monthly output of every plant, assure the food grade of the salt manufactured in the Italian Monopoly's factories; moreover, they show that provided the crude salt is of a single origin, the chemical composition after processing is not affected by performing the process in four different plants.

## Refined salt evaporated from artificial well brines

In this production cycle, the raw material — fresh brine obtained by dissolution of lenticular deposits of rock salt — undergoes a purification stage with a lime–soda ash system. Then, the purified brine undergoes thermo-compression evaporation and the salt crystallizes. The mother liquor is partly recycled to the purifier after the heat regeneration. The crystallized salt is directly sent to the packaging lines after centrifugation and drying. It should be pointed out that the type of process itself is such as to make possible that the product immediately complies with the requirements for human consumption and may be defined as "refined" salt. Such salt is characterized by a high sodium chloride content and by shape and size homogeneous crystals; in addition, it is free of toxic secondary compounds (Table 4).

The standard controls allowing the regular operation of the thermo-compression plant are also a guarantee of the salt grade. In fact, pH values higher than 12 measured in the purified brine ensure the precipitation both of the calcium and magnesium salts, which is essential for the following evaporation stage and of any toxic compounds, such as lead, cadmium and copper. Specific controls should not be

TABLE 4

TC evaporated salt composition — mineral origin

| | | | Volterra |
|---|---|---|---|
| Loss on drying at 110°C % | | | <0.01–0.04 |
| Figures expressed on a dry basis: | | | |
| Sodium chloride | NaCl | % | 99.6–99.9 |
| Calcium | Ca | % | 0.001–0.003 |
| Magnesium | Mg | % | <0.001* |
| Potassium | K | % | <0.05–0.10 |
| Sulphates | $SO_4$ | % | <0.05–0.20 |
| Matter insoluble in water | | % | ≤0.001 |
| Copper | Cu | mg/kg | <0.05–0.15 |
| Lead | Pb | mg/kg | <0.1* |
| Cadmium | Cd | mg/kg | <0.01* |
| Mercury | Hg | mg/kg | <0.005* |
| Arsenic | As | mg/kg | <0.03* |
| Ammonia | $NH_3$ | mg/kg | <1* |
| Nitrates | $NO_3$ | mg/kg | 0.5–1.0 |
| Nitrites | $NO_2$ | mg/kg | 0.5–1.0 |
| Phosphates | $PO_4$ | mg/kg | <1.0–5.0 |
| Boron compounds | B | mg/kg | <5–10 |

*Limit of determination.

necessary; however, as the rock salt deposits are in an area where the subsoil is rich in borax, the possibility of any boron contamination of the fresh brine during wet mining was considered. For the purpose of food grade salt production and considering as significant variable the boron compounds, two critical steps were singled out in the process: the well delivery (the fresh brine) and after the centrifugation (the dried salt). In the later stages there are no critical points which could adversely affect the food grade characteristics.

Taking into account the fact that boron toxicity only occurs at high concentrations (Dreisbach, 1969) and that already in the 1960s in the USA 1 mg/l was recommended as the maximum limit for drinking water (this being the value confirmed as a guideline for this "undesired" element in the recent EEC Directive no. 80/778 on the specifications of water for human consumption), a maximum boron content in salt of 15 mg/kg was fixed as acceptable. The maximum dietary total salt intake (12 g/day per capita) could only imply a daily boron intake of 0.18 mg against the possible 2 mg which could be swallowed daily with about 2 l of drinking water.

*First critical step*

Considering all the production cycle, the mother liquor feed-back included, it was found by experience that a boron compounds' content in the raw brine up to a boron concentration < 100 mg/l ensures a boron content < 10 mg/kg in the salt. The concentration ranges determined in the finished product during a 10 year period since 1980 showed the following distribution, 8 mg/kg: <1.0–6.0, 71%; >6.0–10.0, 26%; >10.0–11.0, 3%. At present it is considered sufficient to check the boron content in raw brine mean samples once a month.

*Second critical step*

From the conveyor belt at the centrifuge outlet three samples are taken, one for each work shift, and a reduced salt sample representative of the daily production is analyzed. The following frequency distribution of boron concentrations in the salt manufactured in 1990 was noted, 8 mg/kg: <1.0–3.0, 47%; >3.0–6.0, 41%; >6.0–9.0, 10%; >9.0–11.0, 2%.

Also for this salt, subsequent statistical controls are customarily performed by analyzing a sample which represents one month's production. These controls confirm that correct operation of the continuous cycle plant allows production of high purity salt having constant food characteristics which could only be affected by changes occurring during underground dissolution.

## CLASSIFICATION ACCORDING TO AVERAGE CHEMICAL COMPOSITION

The surveys, carried out in order to make sure that all salts manufactured by the different processes comply with the food grade requirements, have enabled us to know better the chemical characteristics typical of each salt, to ascertain the presence of trace compounds and to classify salts according to both their source and their chemical compositions.

Table 5 shows the average composition analytically found in the food grade salt manufactured and packaged in packs in 1990 by Italian Monopoly. Sea salts, whole and refined, the latter in coarse and fine varieties, are marked by a chemical composition in accordance with the original balance of the components' concentrations in the raw material from which they are derived. Concentration values are lower owing to the washing stage. As for the whole salt — an unscreened and undried salt appreciated by particular consumer groups — composition is largely dependent on the quality and quantity of washing brine residues in the finished product. Compared to the whole salt, in the refined one — a more pleasant looking salt — component concentrations show more marked reductions as regards calcium and magnesium compounds and less considerable reductions as regards micro-components. The drying stage removing surface moisture from crystals allows the product to be packaged in cardboard boxes and to be better preserved. On the other hand, the refined salt recovered by evaporating artificial well brines is marked by a high sodium chloride content, as noted before. Besides, alkali components such as potassium and lithium are present in higher concentrations than in the corresponding sea product. Because of its appearance, low moisture content and uniform grain size it is appreciated by consumers, especially as table salt.

### Micro-nutrients

When speaking of nutrition and diet, we often fail to consider a class of elements which has, however, proved important: that of trace elements also called micro-nutrients. A number of studies (Bowen, 1966; Underwood, 1971; WHO, 1973; Delves, 1973; Falchuk, 1991) showed that these elements, although present in foodstuffs in very small quantities, are essential for the occurrence of many vital processes. Many of them are an integral part of the so-called "metal enzymes" which control a number of chemical reactions taking place in our body and some possess an "antioxidizing" activity that is basic to defence against certain diseases (Table 6) (NRC, 1980; SINU, 1987). A greater intake of these last elements

TABLE 5

Food grade salt composition — manufacturing 1990

| | | Source: | Seawater | | Artificial well brine |
|---|---|---|---|---|---|
| | | Method of recovery: | Solar evaporation | | Thermocompression plant |
| | | | Whole coarse | Refined coarse, fine | Refined fine |
| Loss on drying at 110°C | | % | 2.5–3.5 | <0.2–0.8 | <0.01–0.04 |
| Figures expressed on a dry basis: | | | | | |
| Sodium chloride | NaCl | % | 98.0–99.0 | 99.1–99.7 | 99.6–99.9 |
| Calcium | Ca | % | 0.05–0.15 | <0.05–0.10 | 0.001–0.003 |
| Magnesium | Mg | % | 0.05–0.15 | <0.04–0.09 | <0.001* |
| Potassium | K | % | 0.03–0.06 | <0.02–0.05 | 0.05–0.10 |
| Sulphates | $SO_4$ | % | 0.20–0.50 | <0.20–0.40 | <0.05–0.20 |
| Matter insoluble in water | | % | 0.04–0.16 | 0.01–0.10 | ≤0.001 |
| Lithium | Li | mg/kg | 0.20–0.40 | 0.25–0.50 | 1.00–2.00 |
| Strontium | Sr | mg/kg | 25–45 | 20–45 | <2* |
| Manganese | Mn | mg/kg | 2.5–3.1 | <2.0–3.0 | ≤0.3 |
| Iron | Fe | mg/kg | 1.5–5.0 | 1.5–3.0 | 0.5–5.0 |
| Copper | Cu | mg/kg | <0.05–0.50 | ≤0.05 | <0.05–0.15 |
| Zinc | Zn | mg/kg | 1.0–3.0 | 0.5–2.0 | 1.0–1.5 |
| Fluorides | F | mg/kg | 1.1–2.5 | <1.0–2.0 | ≤0.2 |
| Iodides | I | mg/kg | <2–3 | ≤2 | ≤2 |
| Lead | Pb | mg/kg | <0.1–0.2 | ≤0.1 | <0.1* |
| Cadmium | Cd | mg/kg | <0.01* | <0.01* | <0.01* |
| Mercury | Hg | mg/kg | <0.005* | <0.005* | <0.005* |
| Arsenic | As | mg/kg | <0.03* | <0.03* | <0.03* |

*Limit of determination.

seems to be necessary even in industrialized countries in case of unvaried diet (Cairella, 1990).

The micro-nutrient intake with dietary salt is small, in view of the daily amounts consumed. Neither the intake nor any long-term effects should be overlooked. Salt is part of our daily diet and its consumption, as long as it is neither too excessive nor too low, can help to keep the levels of these essential elements in our bodies steady and also to achieve those levels that are estimated as the normal physiological requirements.

Besides noticing the different average chemical compositions of the various salt types produced by Italian Monopoly, an examination of Table 5 suggests the possibility of declaring the average salt composition on the package labels, thus clarifying the difference in the actual concentrations. By doing so, manufacturers would make it clear that, in addition to assuring quality, they do pay attention to and wish to comply with modern consumer requirements for more information. On the other hand, consumers would have an opportunity to find out which product meets their needs better and to choose not only by appearance, packaging and price, but also and especially by contents. With this aim, the Amministrazione dei Monopoli di Stato has put on the market a package of whole salt, "Integrale", whose label shows the average chemical composition.

## CONCLUSIONS

In dietetics, salt has been praised and despised by turn. Regarded by Galen as the source of health and by others, more recently, as the cause of many disorders, it has always proved irreplaceable, mainly as a source of sodium chloride, essential for the human body (Dauphinee, 1960). After adverse campaigns by physicians and nutritionists based on salt being considered as the main cause of hypertension, some studies in the field of nephrology (Campanacci, 1982) seem now to absolve it from suspicion. For salt, even more than for other foods, the health aspect tends to prevail over the nutritional one as well as over that of relevance to any commodity.

From the examples reported, in order to produce salt of acceptable food grade, it is obvious that simple

TABLE 6

Requirements and functions of trace elements in humans

| Elements | Daily requirements (*) | Function | Normal values |
|---|---|---|---|
| Li | Not evaluated | Therapy for manic depressives. (range aimed at 1.0–1.5 mEq/l serum) | <0.01 mEq/l (serum) |
| Sr | Not evaluated | Calcification of bone and teeth | (–) |
| Mn | 2.2–5.0 mg | Involved with various enzyme systems, antibody and lipoprotein formation. | 0.6 mg/l (serum) |
| Fe | 10–20 mg | Oxygen transport | 1 mg/l (serum) |
| Cu | 2.0–3.0 mg | Hemoglobin synthesis, connective tissue metabolism, bone development | 1 mg/l (serum), 2–30 μg/g (nails) |
| Zn | 15–20 mg | Nucleic acid and protein synthesis and degradation, vitamin A metabolism | 1 mg/l (serum) |
| F | 1–3 mg | Essential for teeth, dental caries prophylaxis | (–) |
| I | 100–150 μg | Thyroxin formation | (–) |

(*) Recommended requirements may differ for different age groups and physiologic states, e.g. pregnancy.
(–) No available values.

process controls are sufficient and that it is essential to check the suitability of the crude salt as for solar salt, and of the fresh brine as for salt evaporated from artificial well brines. Responsible voluntary controls by manufacturers are possible with no adverse effects on the cost-benefit balance.

The investigations carried out in order to implement our Quality Assurance Program may seem excessive, but as well as ensuring the full compliance of the salts manufactured by Italian Monopoly with the food grade specifications, they also fill a gap arising from lack of attention to the chemical characteristics of a foodstuff which is usually called "poor". These investigations can be a cue for seeking new opportunities on the food grade salt market. Also, the possibility should not be overlooked of using salt, in agreement with the World Health Organization, as an important carrier of diet complements: food grade salt with added iodine is already recognized worldwide as an important means for preventing endemic goitre.

Even a mere pinch of dietary salt, whether or not supplemented by nutrients, may be a real nutritional or prophylactic aid. It is an easy dietary measure that could improve our health day by day.

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