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Quality Estimation and Iodine Determination of Marketed Edible Iodized Salt at Consumer Level for Better Nutrition

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Six locally manufactured and one foreign manufactured marketed edible iodized salt samples are collected from super stores. These samples are analyzed for impurities like Magnesium Sulphate, Calcium Chloride, Calcium Sulphate, Magnesium Chloride, Sodium Sulphate, Potassium Chloride, Water Insoluble Matter, Acid insoluble Matter, Alkalinity, Iodine content and Trace elements. Most of the samples have purity as NaCl greater than permissible limits as per Codex Alimentarius specifications, while some samples are less pure and are not safe for human consumption. Metal load in all salt samples are in the permissible limits as per Codex Alimentarius specifications except lead (Pb), which is greater than permissible limits in one sample. Iodine content at consumer level is adequate in all salt samples and complies with standard specifications except one sample. On the basis of purity as NaCl the foreign manufactured salt sample and sample LM-5 are superior in quality and Iodine content than other locally manufactured salt samples.

***Keywords**: Salt, impurities, Codex Alimentarius, Trace elements, Iodine content*

INTRODUCTION

Salt is an essential mineral for animal life, composed chemically of sodium chloride. It is an important part of human diet as it is necessary to take a particular amount of salt in food daily for the normal functions of the human body. The UK's Scientific Advisory Committee on nutrition (SCAN) suggested that for an adult, the reference nutrient intake is 4.0gm salt per day (1.6gm or 70 mmole sodium). The FDA does not make a suggestion but refers to Dietary Guidelines for Americans 2005. They suggested that salt to be consumed per day must be less than 2,300 mg of sodium (2.3gm of sodium=5.8gm salt) per day [1]. It is also used for preventing heat cramps and other medicinal purposes. One common medicinal use is for isotonic salt solutions. It is commonly used in preserving and seasoning foods such as in curing meat, other meat products, curing fish, making pickles, preserving other vegetables, canning vegetables, meat baking and many other familiar house hold uses [2].

Pakistan is one of the few countries that have been bestowed with all types of available salt in the world i.e. rock salt, sea salt and lake salt. Salt mines of salt range are the oldest mines of the sub-continent from the eastern terminal part of the salt range [3], the plugging of the salt has been out cropped at different places like Warcha, Kalabagh, Khewra, Jatta and Bahadurkhel, which produce many thousands tons of salt annually [4].

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However, salt is produced in different forms i.e., unrefined salt (such as sea salt), refined salt (table salt), and iodized salt. Refined salt, which is most widely used presently, is mainly sodium chloride. The food grade salt accounts for only a small part of salt production in industrialized countries (3% in Europe [5]) although world-wide, food uses account for 17.5% of salt production [6]. Today, most refined salt is prepared from rock salt. These rock salt resources were obtained by the evaporating of old salty lakes [7].

These resources may be gotten by conventional method or via the injection process of water. Such injected water works to dissolve salt, meanwhile the salty solution may be pushed to surface where the salt is collected from brine. This raw form of salt is refined and purified. This purification is also called recrystallization process. In this method, the salty solution is also mixed with chemicals for precipitation of impurities (mostly Calcium and Magnesium salts) [8]. Several steps of evaporation are utilized for collection pure crystals of sodium chloride.

This table salt is refined after purification and mixed with a small amount of Potassium Iodide (KI), or Sodium Iodide (NaI), or Iodate, to reduce the Iodine deficiency in human beings. While keeping the important of Iodine (I), which is mandatory for the production and proper function of thyroid hormones inside the body [9]. The deficiency of causes Iodine Deficiency Disorder (IDD) which is considered a common group of diseases. This IDD varies from abortion/stillbirth to the formation of goiter or impaired mental disorder [10].

The Iodine is an important element works for the prevention of insufficient production of thyroid hormones (hypothyroidism), which produce goiter, while cretinism in children, and meanwhile myxedema in young. The Iodized common salt reduced disorders of iodine deficiency significantly in countries where it is utilized [11]. The IDD affected roundabout 30 percent of world population, where 655 million people across the world is reported with goiter [12]. This IDD affected about 50 million population in Pakistan, in which 6.5 million people are affected seriously [13].

The Pakistani Government in collaboration of UNICEF initiated a struggle to cope with the IDD by the utilization of iodized salt and advertized extensive attentiveness via media both print and electronic sources. The marketing of iodized oil and supplementation of iodized salt during 1985-1995 was carried out among four million persons [14]. The production, and distribution of non-iodized salt is banned in Khyber Pakhtunkhwa and Baluchistan since 1994 and 1995 effective through legislation respectively. This study is little forward to our previous studies [15]. In the present work marketed salt samples were assessed for its quality parameters, purity as sodium chloride, trace metals and iodine content at consumer level.

METHODOLOGY

Chemicals used for the analysis are all of analytical grade and used without further purification. Water used was doubly distilled over alkaline $KMnO_4$.

Sample preparation

The salt samples were crushed, grinded and sieved -80 mesh and stored in appropriate air tight glass containers. Weighed 5.0gm of each samples and added slowly to a beaker containing 100 ml doubly distilled water and a magnetic stirrer. Stirred the salt solution for 5 minutes, then the residue was separated by vacuum filtration for water insoluble matter and preparing the volume of the filtrate up to 500 ml in a volumetric flask as a stock solution for further analysis as per ASTM and AOAC methods [19-20].

Separate samples were taken for the determination of iodine content and acid insoluble matter as per AOAC methods [20].

Atomic Absorption spectrophotometer

The salt samples solution were prepared by dissolving 5.0 gm of powdered sample in 10.0 ml of Nitric acid and 90.0 ml of doubly distilled water in 100 ml of volumetric flasks. These solutions were heated to ensure metal ions dissolution. The solutions were filtered to remove any insoluble matter. The trace elements were analyzed by atomic absorption spectrophotometer having specification as (Model#Z-8000, Hitachi, Japan).

DISCUSSION AND ANALYSIS

The six different local brands and one foreign brand edible iodized salt samples were collected followed analysis by conventional and instrumental methods [16-20]. These samples are analyzed for moisture content, alkalinity, water insoluble matter, acid insoluble matter, alkalinity and purity as per ASTM standard method [19]. The experimental results are given in Table-1 below.

Table-1. Solubility of salt in acid and water, alkalinity, purity and moisture contents

Salt 2samples	**Acid insoluble %**	**Alkalinity as Na_2CO_3 %**	**Water insoluble %**	**Moisture %**	**Purity* as NaCl %**
LM-1	0.146 ±0.002	0.067 ±0.001	0.152 ±0.002	0.078 ±0.002	98.75
LM-2	0.160 ±0.003	0.075 ±0.001	0.640 ±0.012	0.230 ±0.017	96.94
LM-3	0.130 ±0.002	0.112 ±0.0 02	0.920 ±0.016	0.170 ±0.015	96.60
LM-4	0.270 ±0.002	0.570 ±0.012	0.330 ±0.014	0.077 ±0.002	94.42
LM-5	0.140 ±0.002	0.440 ±0.018	0.400 ±0.019	0.070 ±0.001	98.20
LM-6	0.020 ±0.002	0.460 ±0.019	0.040 ±0.002	0.009 ±0.001	96.94
FM	0.320 ±0.017	0.075 ±0.002	0.380 ±0.015	0.016 ±0.001	99.38

The presence of different salts and radicals such as Potassium (K^+), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Sulphate (SO_4^{-2}) and Iodine are determined and the results are recorded in table 2 as per ASTM standard method [19].

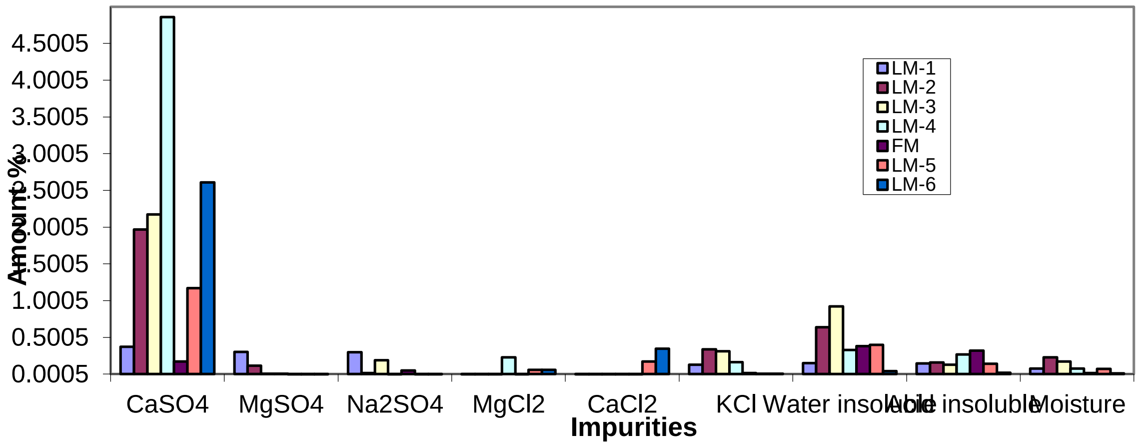
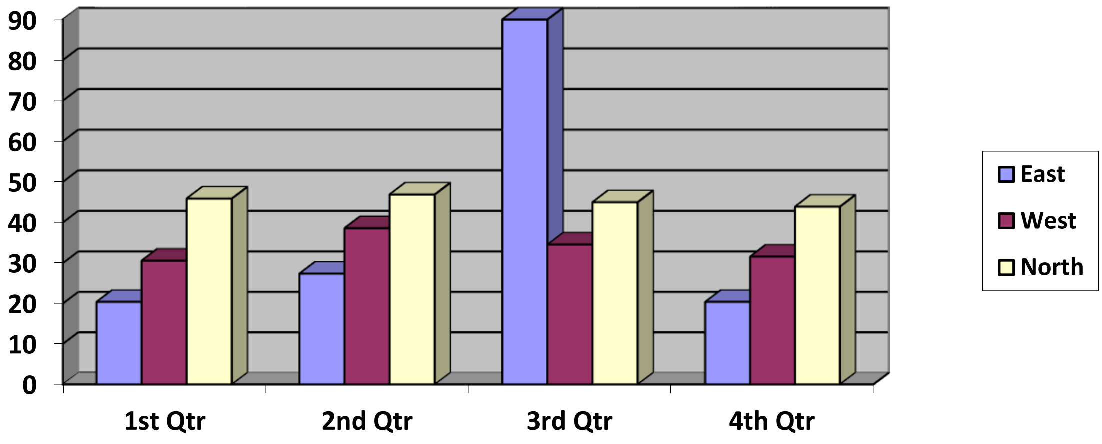


Figure.1 Composition of different Salts (as impurities in salt samples)

The table-1 shows that the moisture content ranges from 0.009% (LM-6) to 0.23%(LM-2), alkalinity as Na_2CO_3 ranges from 0.067% (LM-1) to 0.570 % (LM-4), Water insoluble matter from 0.04% (LM-6) to 0.92% (LM-3), Acid insoluble matter from 0.02% (LM-6) to 0.32% (FM), $CaSO_4$ from 0.173% (FM) to 4.86 % (LM-4), $MgSO_4$ from 0.00 (FM, LM-5 & LM-6) to 0.114(LM-2), Na_2SO_4 from 0.00 (LM-4, 5 & 6) to 0.297% (LM-1), $MgCl_2$ from 0.00 (LM-1,2,3& FM) to 0.227% (LM-4),$CaCl_2$ from 0.00 (LM1,2,3,4 & FM) to 0.347% (LM-6), KCl from 0.006% (LM-5 & 6) to 0.339% (LM-2).The presence of small amounts of different salts in small amount (considered as impurities) in all salt samples are shown in figure-1and table 2.

Table -2 Percentage ratios of different salts (as impurities in salt samples)

Salt samples	**$CaSO_4$ %**	**Na_2SO_4 %**	**$MgSO_4$ %**	**$MgCl_2$ %**	**$CaCl_2$ %**	**KCl %**
LM-1	0.374 ±0.009	0.297 ±0.015	0.304 ±0.016	0.000	0.000	0.128 ±0.002
LM-2	1.970 ±0.024	0.014 ±0.002	0.114 ±0.013	0.000	0.000	0.339 ±0.018
LM-3	2.174 ±0.010	0.188 ±0.015	0.003 ±0.001	0.000	0.000	0.310 ±0.018
LM-4	4.860 ±0.103	0.000	0.003 ±0.001	0.227 ±0.003	0.000	0.162 ±0.013
LM-5	1.172 ±0.011	0.000	0.000	0.060 ±0.001	0.171 ±0.015	0.006 ±0.002
LM-6	2.609 ±0.054	0.000	0.000	0.060 ±0.001	0.347 ±0.014	0.006 ±0.002
FM	0.173 ±0.015	0.050 ±0.001	0.000	0.000	0.000	0.150 ±0.015



Results are given by calculating means of Six times analysis of each sample with Standard deviation.

* Purity determined as per ASTM standards E 534-98 (2002).

Salt samples LM.2, 3, 4 and 6 have purity as NaCl less than Codex Alimentarius specifications [21], and are not safe for human consumption while salt samples LM-1, 5 and FM are safe for human consumption. The purity of all salt samples are given in the figure 2 below.

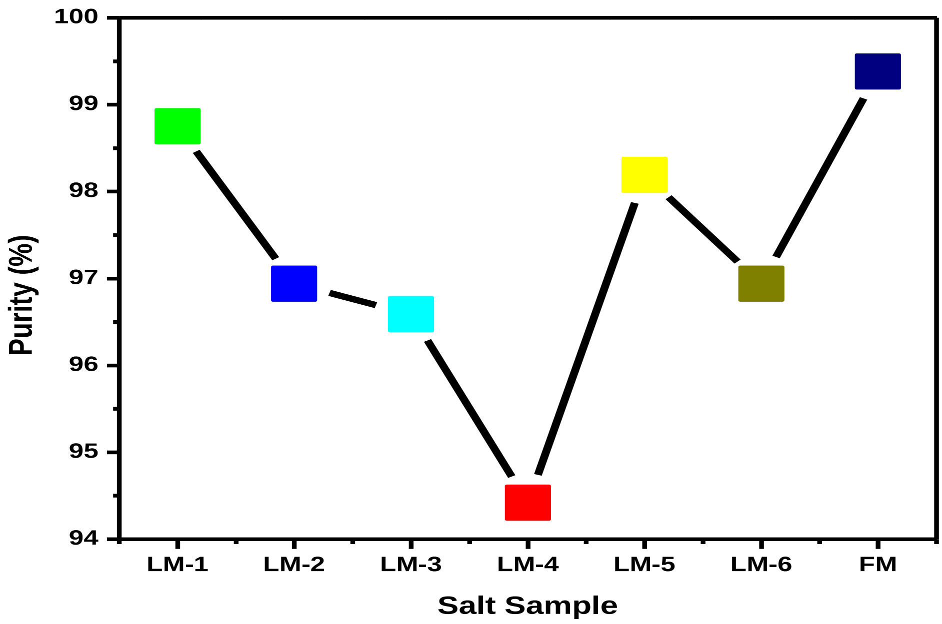


Figure-1. Purity of different salt samples LM-1 to LM-6 and FM

The Acid insoluble matter is also higher for all salt samples than ICRC standard specifications [22] except sample LM-6.The recommended alkalinity as Na_2CO_3 is with in permissible limits for sample LM-1, 2, & FM while it is higher than permissible limits for sampleLM-3, 4, 5 & 6.

Trace elements have important consequences due to their affinity to accommodate inside human organs over a prolonged period of time. The occurrence of trace metals beyond the permissible upper and lower limits is responsible for metabolic disturbance. Thus the deficiency and as well as the excess of trace metals may produce undesirable effects [23]. Trace elements (Fe, Zn, Pb, Ni, Mn, Cr, Cd & Co) were analyzed with the help of atomic absorption spectrophotometer. The results of trace elements are given in Table-2. There was no presence of trace metals (Mn, Cr, Cd and Co) in all salt samples, however Fe, Zn, Pb and Ni were found in various amounts in all samples.

Sample LM-1, 4 & FM has permissible level of iron as per RDA limit of 50-400 µg/day, while sample LM-2, 3, 5 & 6 has no iron content. Iron exhibits an important role in the metabolism inside human body. It acts as a catalyst and it is present in greater quantity than any other trace element [24]. Sample LM-2, 3 & FM has no lead (Pb) content while sample LM-4, 5 and 6 has permissible Level of lead content. Sample LM-1 has 2.95 mg/kg of lead, which is greater than codex alimentarius standard specifications. [21]

Lead is a toxic trace metal and is a cumulative poison, which is found in surface/ground water as a result of its dissolution from natural sources [25]. Lead is regarded as high hazardous for plants & animals. Long term intake or exposure may cause in accumulation of lead inside the body and may cause more severe symptoms. These include pale skin, anemia, decrease handgrip strength, vomiting, nausea, abdominal pain, and paralysis of the wrist joint, chances of miscarriage or birth defects [26].

Amount of Zinc ranges from 0.92 mg/kg (LM-3) to 4.56 mg/kg (LM-5). Zinc (Zn) is an important element playing a range of functions in the body, beside this Zn is cofactor for a number of enzymes, however no health based guidelines values has been proposed by codex alimentarius. The concentration range of Ni in the analyzed samples is from 1.84 mg/kg (LM-3) to 7.87 mg/kg (LM-1), while there is absence of Ni in sample FM. However no health based guidelines values has been proposed by codex alimentarius for nickel. Iodine was also determined in these samples and shown in figure 3. Salt containing (0-7 PPM) iodine content is low, (7-15 PPM) iodine content is moderate and from (>15 PPM) is adequate [27].

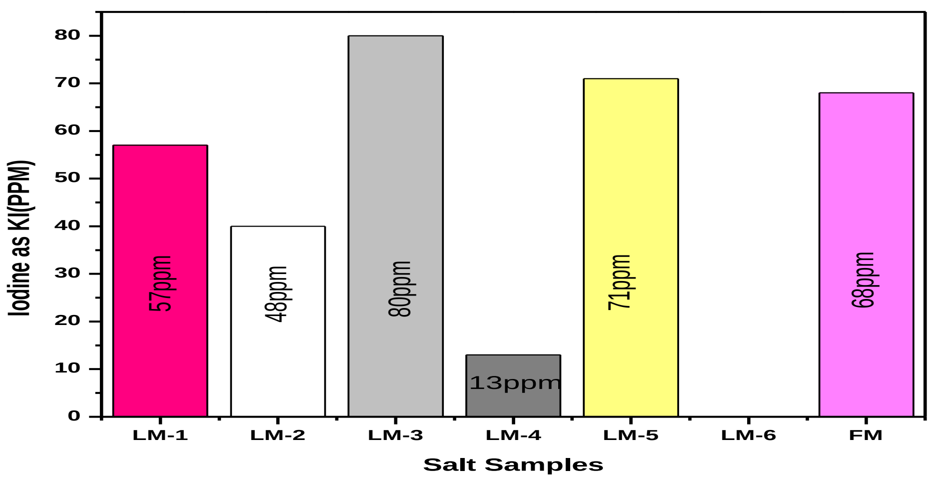


Figure 3. Iodine contents in different salt samples

It is suggested plan that the iodization level is set at a minimum of 15 PPM at customer level and 30 PPM at manufacturing level [28]. Iodine content in all samples is adequate (> 15 PPM) except Sample No. LM-4 where iodine content is moderate and sample No.LM-6, where iodine content is low. The results are given in Table-3.

Table-3. Iodine content in different salt samples including as

Salt samples	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	FM
Iodine as KI (PPM)	57	40	80	13	71	NIL	68

CONCLUSION AND RECOMMENDATIONS

From the present study, it is clear that nearly all salt locally produced are not safe for human consumption due to impurities although iodine supplementations is proper in most of the samples. The salt sample FM that is foreign brand sample is purified and safe for human consumption.

It is recommended that routine assessment of the quality of edible iodized salt at salt deposits and purifying plants at salt refineries should be undertaken by the concerned authorities and if found unsatisfactory, the manufactures should be subjected to punitive measures.

The salt is readily available in the country but will only be successful in combating dietary nutrient deficiencies if the government, health agencies and salt producers combine together.

REFERENCES

1. US Department of Health and Human Services. (2005). Dietary guidelines for Americans 2005. *http://www. health. gov/dietaryguidelines/dga2005/document/default. htm*.

2. Firestone, D. (1994). Determination of the iodine value of oils and fats: summary of collaborative study. *Journal of AOAC International*, *77*(3), 674-676.

3. Simurdiak, M., Olukoga, O., & Hedberg, K. (2016). Obtaining the iodine value of various oils via bromination with pyridinium tribromide. *Journal of Chemical Education*, *93*(2), 322-325.

4. Das S, Dash HR (2014). *Laboratory Manual for Biotechnology*. S. Chand Publishing. p. 296. ISBN 978-93-83746-22-4.

5. Miyake, Y., Yokomizo, K., & Matsuzaki, N. (1998). Rapid determination of iodine value by 1H nuclear magnetic resonance spectroscopy. *Journal of the American Oil Chemists' Society*, *75*(1), 15-19.

6. Hilp, M. (2002). Determination of iodine values according to Hanuš using 1, 3-dibromo-5, 5-dimethylhydantoin (DBH): Analytical methods of pharmacopeias with DBH: part 7. *Journal of pharmaceutical and biomedical analysis*, *28*(1), 81-86.

7. Akoh CC, Min DB. (2002). *Food Lipids: Chemistry, Nutrition, & Biotechnology* (Second Ed.). CRC Press. ISBN 978-0-203-90881-5.

8. Andersen AJ, Williams PN. (4 July 2016). *Margarine*. Elsevier. pp. 30–. ISBN 978-1-4831-6466-3.

9. C. Bellamy "Global Iodine deficiency day spectrum" *The medical spectrum*: **16:9**-10(1995).

10. Kapil, U. (2007).Health consequences of iodine deficiency. *Sultan Qaboos University Medical Journal*, *7*(3), 267.

11. Paech K, Tracey MV. (2013). *Modern Methods of Plant Analysis / Modern Methoden der Pflanzenanalyse* Vol. 2. Springer Science & Business Media. p. 335. ISBN 978-3-642-64955-4.

12. Van der Haar, F. (1997).The challenge of the global elimination of iodine deficiency disorders. *European journal of clinical nutrition*, *51*, S3-8.

13. Rafiq, M. (1996). Iodine deficiency disorders control program in Pakistan: an analytic review. *University of Leeds*.

14. Fazizi.IDD in the Middle East. *IDD News Letters* 17(3): 33-41 (2001).

15 Kuhn, T., Chytry, P., Souza, G. M. S., Bauer, D. V., Amaral, L., & Dias, J. F. (2020). Signature of the Himalayan salt. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, *477*, 150-153.

16. Furman, N. H. (Ed.). (1962). *Standard Methods of Chemical Analysis: Vol. 1*.

17. M.Artho and R.kelly *Analytical Chemistry*. John Willey and Sons.Inc.New York (1998).

18. Jeffery, G. H., Mendham, J., Denney, R. C., & Bassett, J. (2016).*Text book of quantitative chemical analysis*.

19. Langer, H., & Offermann, H. (1982).On the solubility of sodium chloride in water. *Journal of crystal growth*, *60*(2), 389-392.

20. Association of Official Agricultural Chemists, & Horwitz, W. (1975). *Official methods of analysis* (Vol. 222). Washington, DC: Association of Official Analytical Chemists.

21. Codex Alimentarius Commission. (2006). The Codex Standard for Food Grade Salt. *Codex Stan 150*.

22. ICRC, *Emergency relief items Catalogue* (2002).

23. Kabata-Pendias, A. (2000). *Trace elements in soils and plants*. CRC press.

24. Hardisty, R. M., & Weatherall, D. J. (1974).Blood and its disorders.In *Blood and its disorders* (pp. 1540-1540).

25. Mohod, C. V., & Dhote, J. (2013).Review of heavy metals in drinking water and their effect on human health. *International Journal of Innovative Research in Science,Engineering and Technology*, *2*(7), 2992-2996.

26. Alloway, B. J. (1990). Heavy metals in soils, edited by: Alloway. *BJ, Blackie,Glasgow and London*.

27. Ullah, Z. (2004). Impact assessment of salt iodization on the prevalence of goiter in district swat.

28. Pandav, C. S., Arora, N. K., Krishnan, A., Sankar, R., Pandav, S., & Karmarkar, M. G. (2000). Validationof spot-testing kits to determine iodine content in salt. *Bulletin of the World Health Organization*, *78*(8), 975-980.