

# Impact evaluation of efforts to eliminate iodine deficiency disorders in Nigeria

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## Abstract

*Objective:* The objective of the present review is to assess the impact of universal salt iodisation in Nigeria during the last five years, with reference to some of the sentinel sites studied previously during a 1995 multi-centre study.

*Design, setting and subjects:* The method of goitre classification by palpation was employed using the new internationally accepted method in which the classification is simply graded as 0, 1 or 2. The multistage random sampling method was used and states and local government areas were already selected by virtue of their known status for iodine deficiency disorders (IDD). Schools were randomly chosen in each local government area and children aged 8–12 years in each school were determined. A percentage of the children was then included in the study to give a sample size greater than the minimum number allotted to the school. A total of 2372 schoolchildren (1420 males and 952 females) in 11 local government areas were examined; urine samples were collected from 537 children and analysed for urinary excretion of iodine. The method known as the Sandell–Kolthoff reaction was adopted, in which the iodide in the urine samples catalyses the reduction of ceric ammonium sulphate (yellow colour) to the cerous form (colourless) in the presence of arsenious acid. The degree of reduction in colour intensity of the yellow ceric ammonium sulphate is proportional to the iodine content in the urine sample.

*Results:* The results from this study show that the median urinary iodine excretion for this sampled population in Nigeria, drawn mostly from IDD-endemic areas, is  $14.65 \mu\text{g dl}^{-1}$  with a mean value of  $13.39 \mu\text{g dl}^{-1}$ .

*Conclusion:* This finding would suggest that Nigeria, in general terms, has achieved the goal of universal salt iodisation and should now focus its attention on constant monitoring in order to sustain this iodisation level.

**Keywords**  
Iodine deficiency disorders  
Goitre  
Hyperthyroidism  
Hypothyroidism  
Universal salt iodisation  
Urinary iodine excretion  
Virtual elimination

The World Summit for Children (WSC) in 1990 resolved to virtually eliminate iodine deficiency disorders (IDD) by the year 2000. This resolution was made on the strength of available evidence that iodine deficiency was a singular cause of most cases of mental retardation in children and equally one of the factors contributing to high infant mortality<sup>1</sup>. Lack of iodine at the stage of conception has the most dramatic consequences, which leaves the individual more or less a burden to the national social system<sup>2,3</sup>. Awareness of IDD and its control through salt iodisation were slow to arrive in sub-Saharan Africa, and remedial programmes were introduced less than 10 years ago. The World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) have been at the forefront in the drive to eradicate IDD in Africa. Progress in the field started in 1985 with mobilisation of WHO interest on IDD in Africa, followed by a WHO/UNICEF/ICCIDD-sponsored IDD

seminar in Younde, Cameroon<sup>4</sup>. Subsequent to this were the appointment of an IDD Task Force for Africa, the appointment of three sub-regional co-ordinators and the creation of a Special Trust for IDD in Africa. In 1986 the Afro Committee in Bamako, Mali, sponsored by Cameroon and Nigeria, adopted a similar resolution. The resolution urged the WHO and UNICEF to take further proactive official action to promote the control of IDD.

The entire landscape of Nigeria predisposes the country to IDD because of its proximity to the equator and the long months of rainfall ranging from April to November. Due to an increased level of awareness Nigerians are beginning to understand that goitre, an enlargement of the thyroid gland, is the result of a lack of iodine in the body. Many people erroneously believed that goitre resulted from witchcraft activities and in other communities a woman without goitre was not considered beautiful since the resultant roundness of the neck was perceived as a mark of feminine beauty.

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As early as 1965, Ekpechi alerted the Federal Ministry of Health of Nigeria to the IDD problem in the country and a Ministerial Committee on Iodization of Salt was formed in 1974. This committee wound up in 1976 due to poor funding but again Ekpechi's untiring advocacy resulted in the meeting of a Ministerial Expert Committee on IDD in Enugu in 1988. This committee recommended advocacy at all levels, setting up a National Committee on Control of IDD. The committee again went into abeyance, due to administrative and funding problems.

The early studies of Ekpechi, Nwokolo and Olurin showed that IDD was a public health problem in Nigeria<sup>5–8</sup>. More findings were made in 1987 by Isichei *et al.*<sup>9</sup> that led to the production of the first goitre map for Nigeria. In response to the 1990 WCS call for the virtual elimination of IDD, an IDD baseline study<sup>10</sup> was carried out in 1993 as a prelude to the introduction of a universal salt iodisation programme. This study was very extensive in scope, covering all 30 states of Nigeria, with emphasis on the previously surveyed hyper-endemic local government areas (LGAs) in eight states of the country. The prevalence of IDD was established by the measurement of total goitre rate (TGR), but measurement of the median urinary iodine in the surveyed populations was lacking. Following this study the TGR for Nigeria was put at 20%, thereby generating public health concern (Fig. 1). The risk of IDD is quite high in Nigeria, a country that has a well-demarcated goitre belt, where almost all the inhabitants within the belt live on cassava-based food staple<sup>11</sup>. At least 60 million Nigerians (from a population of about 120 million) are at risk of IDD.

Consequently, the Standards Organisation of Nigeria (SON) instituted the mandatory iodisation of salt in January 1994 and within 12 months it was possible for 95% of Nigerian households to have access to adequately iodised salt.

Closely following this milestone was a multi-centre study on the possible existence of iodine-induced

hyperthyroidism (IIH) in Nigeria, which took place in 1995. This study was sponsored by the WHO and facilitated by the ICCIDD in response to a retrospective study conducted in Zimbabwean hospitals that showed a sudden emergence of IIH. The hypothesis of this study was that the introduction of universal salt iodisation in any given population leads to an increased activity in the thyroid gland of the individuals living in that population. Following the observation in Zimbabwe, the ICCIDD, with funding support from the WHO, commissioned a seven-country multi-centre study that included Cameroon, Kenya, Nigeria, Tanzania, Zaire, Zambia and Zimbabwe. An eighth country, Botswana, was included in the study as a major salt producer. A rapid survey of the status of salt iodisation in these countries and the measurement of urinary iodine excretion rates were some of the objectives of this study.

In Nigeria, the report indicated that 97% of households had access to adequately iodised salt. The ranges of urinary iodine excretion for Uzo-Uwani and Akoko-Edo LGAs, two sentinel LGAs where the study was carried out, were 5.5–325  $\mu\text{g dl}^{-1}$  and 5.5–120  $\mu\text{g dl}^{-1}$ , respectively<sup>12</sup>.

It has been five years (1995–1999) since universal salt iodisation started in Nigeria following a long period of advocacy with medium and high policy makers, regulatory agencies and the salt industry. In those years, fairly regular monitoring of the salt produced by industry and at ports of entry has been carried out by the National Agency for Food, Drug Administration and Control (NAFDAC) and SON by titrimetric analysis, and at the household level by nutrition officers across the country, using semi-quantitative rapid field test kits. The objective of the present review is to assess the impact of universal salt iodisation in Nigeria in the last five years, with reference to some of the sentinel sites studied previously during the 1995 multi-centre study.

The quickest means of eliminating IDD is by universal salt iodisation. Completed surveys in some African countries such as Cameroon, Liberia, Benin Republic

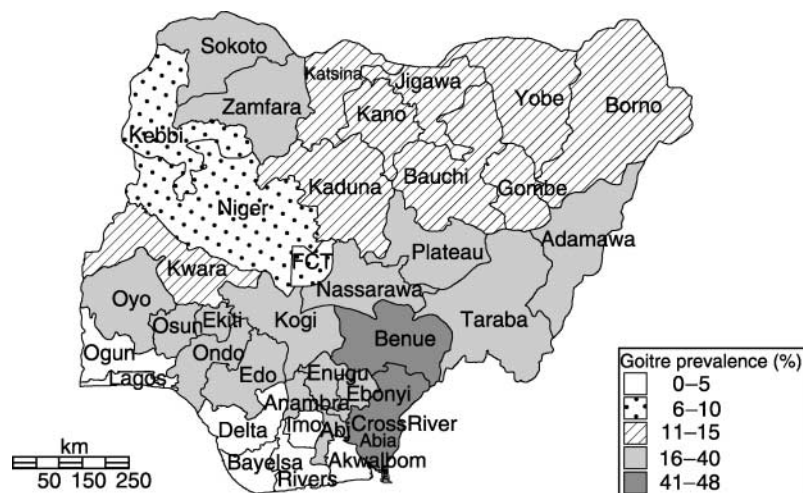


Fig. 1 Prevalence of endemic goitre in Nigeria by state, 1993

**Table 1** Results of surveys on total goitre rate (TGR) conducted in some African countries before and after universal salt iodisation (USI)

Country	% of households consuming iodised salt	TGR before USI (%)	TGR after USI (%)
Cameroon	100	29 (1990)	14 (1995)
Benin	79	24 (1991)	11 (1999)
Liberia	85	7 (1991)	5 (1998)
Tanzania	74	52 (1988)	23 (1991)

Source: State of the World's Children Reports and presentations at the IDD conference of anglophone West African countries, 1999.

and Tanzania tell a lot about the sudden rise in the proportion of households in these countries having access to iodised salt. In these countries also a decrease in TGR and an increase in median urinary iodine excretion have been reported (Table 1).

### Methodology

The method of goitre classification by palpation was employed using the new internationally accepted method in which the classification is simply graded as 0, 1 or 2.

The multistage random sampling method was used. In the first and second stages the states and LGAs were already selected by virtue of their known IDD status. In the third stage, three schools were randomly chosen in each LGA. In the fourth stage classes with pupils aged 8–12 years in each chosen school were identified and a percentage of the children was then included in the study to give a sample size greater than the minimum number allotted to the school. In the fifth and sixth stages every fifth child examined (20%) produced a casual urine sample that was analysed for urinary iodine concentration at the Chemical Pathology Laboratory located at the University of Nigeria Teaching Hospital in Enugu.

A total of 537 samples were analysed for urinary excretion of iodine (UEI). The method known as the Sandell–Kolthoff reaction<sup>2</sup> was adopted, in which the iodide in the urine samples catalyses the reduction of ceric ammonium sulphate (yellow colour) to the cerous form (colourless) in the presence of arsenious acid. The degree of reduction in colour intensity of the yellow ceric ammonium sulphate is proportional to the iodine content in the urine sample. This method was applied to all urine samples. The results of the present study (1998) were analysed using EPI/INFO (Centers for Disease Control/WHO), which contains a special module for the analysis of cluster sampling.

### Results

Table 2 gives an account of the various surveys conducted in Nigeria in 1993, 1995 and 1998. It lists the TGR in 10 of the 36 states in Nigeria where IDD studies have been

**Table 2** Total goitre rate (TGR) for selected local government areas (LGAs) in 1993, 1995 and 1998

State	LGA	TGR (%)		
		1993	1995	1998
Enugu	Uzo-Uwani*	67	40	9.8
Cross River	Obudu/Obanliku*	62	N/a	14.9
Benue	Okpokwu*	60		9.4
Edo	Akoko-Edo*	32	26	30.4
Ekiti	Ekiti East*	38	N/a	33.3
Oyo	Saki (Ifedapo)*	36	N/a	16.2
Katsina	Bakori†	11	N/a	2.9
Zamfara	Anka†	22	N/a	2.9
Kano	Gwarzo†	13	N/a	4.1
Plateau	Bassa*	26	N/a	4.7

N/a – not available.

\* LGAs where iodine deficiency disorders (IDD) are hyper-endemic.

† LGAs where IDD was not previously known as a public health problem.

carried out continuously since 1993. The table also shows the seven IDD hyper-endemic LGAs and three LGAs where IDD was not previously known as a public health problem. The method used in each case was the palpation method using the standard classification of 0, 1 and 2.

Table 3 shows the range, median and mean levels of urinary iodine in  $\mu\text{g dl}^{-1}$  in the seven states and LGAs that were previously known to be IDD hyper-endemic, as well as in the three newly identified LGAs. In all, 537 urine samples were collected from school-aged children in the 10 locations.

### Discussion and conclusions

The WSC resolution was quite an ambitious one, declaring the year 2000 as a target for the virtual elimination of IDD globally. The IDD landscape in Nigeria changed significantly between 1993 and 1998, using as indicators measurements of TGR and UEI. The prevalence of goitre gives an idea of the past history of iodine nutrition at the population level. Palpation is the simplest method for measuring thyroid size. However, palpation becomes imprecise as the majority of goitres in a population diminish in size, i.e. following implementation of a national salt iodisation scheme. In this case measurement of thyroid volume is more accurately performed by ultrasound<sup>13</sup>. Much of the recent IDD assessment work done in Europe was accomplished by ultrasonography transported across countries and borders by van<sup>14</sup>. In West Africa a similar exercise has just been concluded in Benin, Togo, Burkina Faso and Niger.

In this study a total of 2372 schoolchildren in 11 LGAs in 10 states were examined. The schoolchildren were distributed into 1420 males and 952 females<sup>15</sup>. Schoolchildren aged 8–12 years were used for the goitre survey and the estimation of UEI. Goitres are easily detectable in this age group and the changes associated with improved iodine supply more likely to occur earlier in them than in adults.

**Table 3** Values of urinary excretion of iodine (UEI) obtained from the last survey conducted in 1998

State	LGA	<i>n</i>	Range ( $\mu\text{g dl}^{-1}$ )	Median ( $\mu\text{g dl}^{-1}$ )	Mean ( $\mu\text{g dl}^{-1}$ )	Standard deviation
Enugu	Uzo-Uwani*	46	10.6–20.0	15.65	15.72	2.75
Cross River	Obudu/Obanliku*	80	6.4–20.0	14.70	14.75	3.88
Benue	Okpokwu*	94	1.0–19.8	14.80	14.03	4.75
Edo	Akoko-Edo*	41	1.0–19.4	14.00	13.96	4.11
Ekiti	Ekiti East*	42	5.8–19.8	14.60	13.56	3.81
Oyo	Saki (Ifedapo)*	56	1.6–20.0	9.20	9.15	5.17
Katsina	Bakori†	29	5.2–16.8	10.60	11.35	3.77
Zamfara	Anka†	62	6.5–20.0	15.55	14.59	4.20
Kano	Gwarzo†	37	3.0–20.0	12.60	11.45	5.08
Plateau	Bassa*	50	10.0–19.4	15.50	15.06	2.83
Total		537	1.0–20.0	14.65	13.39	4.04

LGA – local government area.

\* LGAs where iodine deficiency disorders (IDD) are hyper-endemic.

† LGAs where IDD was not previously known as a public health problem.

The decreasing trend of levels of IDD using measurement of TGR is shown in Table 2. Most significant are the changes observed in Uzo-Uwani, Obudu and Okpokwu LGAs, where the TGR in each of these areas was above 60% in 1993. In each of these LGAs located in the south-east of Nigeria, the rate of decrease over a period of five years is greater than 75%. The same rate of decrease is observed in Bakori, Anka, Gwarzo and Bassa LGAs, all in northern Nigeria. It is not clear why the decrease in goitre rate observed in Akoko-Edo, Ekiti East and Ifedapo LGAs is not as dramatic as others observed in this study. These LGAs are located within the same geographical and cultural zone in western Nigeria, which may imply the involvement of a common factor such as food pattern. The disparity in the dietary patterns of the various ecological zones in Nigeria could be responsible for the differential reduction rates observed between western Nigeria and other parts of Nigeria.

The progress towards elimination of IDD in south-eastern Nigeria is very remarkable particularly in Uzo-Uwani LGA, where the prevalence was 67% in 1993<sup>10</sup> but had fallen to 9.8% in 1998. The 1995 multi-centre study had put goitre prevalence in that LGA at 40%.

Also, it is not clear why the 1998 TGR rate in Akoko-Edo LGA is as high as 30.4% after the level had been noted by an international team in 1995 to be 26%, down from 32% in 1993. However, it should be noted TGR as a measure of IDD is fraught with unavoidable human errors and personal bias and, for this reason, is gradually becoming obsolete, particularly in the developed world.

Iodine deficiency is not the sole cause of endemic goitre. Indeed, the disease has been found in regions where there is no iodine deficiency<sup>16</sup>. Conversely, in other regions with an extremely severe iodine deficiency, endemic goitre is not observed<sup>17</sup>. These data strongly suggest that some goitrogenic factors in the diet or environment, other than iodine, could play a critical role in the aetiology of the disease<sup>18,19</sup>. Natural goitrogens were first found in vegetables of the genus *Brassica*

(the Cruciferae family), which possesses goitrogenic properties in animals<sup>20</sup>. Their antithyroid action is related to the presence of thioglucosides, which, after digestion, release thiocyanate and isothiocyanate. Another important group of naturally occurring goitrogens is the cyanoglucosides, which have been found in several staples (cassava, maize, bamboo shoots, sweet potatoes, lima beans)<sup>21,22</sup>. After ingestion, these glucosides release cyanide, which is detoxified by conversion to thiocyanate, a powerful goitrogenic agent that inhibits thyroid iodide transport and, at higher doses, competes with iodide in organification processes<sup>23</sup>. In Akoko-Edo and Ekiti East LGAs, which are contiguously located in western Nigeria, the major food staple is cassava, a noted goitrogen whose presence in the diet could explain why the rate of decline in TGR in these two LGAs is not as sharp as those observed in the eastern part of the country.

The use of UEI rate as a measure of IDD status provided a more vivid indication of the virtual elimination of IDD in previously endemic sites, as clearly shown in Table 3. A median urinary iodine excretion rate in excess of  $10 \mu\text{g dl}^{-1}$  in a given population is indicative of iodine sufficiency in that population. In all of the LGAs assayed in this study except one (Ifedapo, with  $9.20 \mu\text{g dl}^{-1}$ ), the median excretion of urinary iodine exceeded  $10 \mu\text{g dl}^{-1}$ . Urinary iodine excretion measurements are indicative of current dietary intake of iodine and, although the multi-centre study determined urinary iodine excretion rates in only Uzo-Uwani and Akoko-Edo, it is evident from this present study that the populations in these LGAs were iodine-sufficient. All subjects examined in Uzo-Uwani and Bassa had adequate urinary iodine excretion (above  $10 \mu\text{g dl}^{-1}$ ). In Okpokwu, Obudu/Obanliku, Bakori and Anka LGAs, more than 70% of the subjects had urinary iodine excretion greater than the threshold value of  $10 \mu\text{g dl}^{-1}$ . The slightly low urinary iodine excretion rates in Ifedapo (Saki) and Gwarzo LGAs may not be unconnected with the reported inundation of the areas with non-iodised industrial salt by some unscrupulous traders.

There is a strong statement emerging from the two studies of urinary iodine in Nigeria, which is that the country is generally iodine-sufficient. As can be seen in Table 3, the median urinary iodine excretion for the sampled population, drawn mostly from IDD-endemic areas, is  $14.65 \mu\text{g dl}^{-1}$  with a mean value of  $13.39 \mu\text{g dl}^{-1}$ . If this picture holds true for the rest of the country, Nigeria would rank among the countries where the universal salt iodisation scheme has achieved the desired impact. For the communities sampled, the health and socio-economic burden of IDD has been lessened, which translates into improved child survival, improved educability, independence and productivity, and improved earning power. The regular and routine measurement of iodised salt using the field test kit over the last three years has consistently indicated the availability of adequately iodised salt to about 96% of Nigerian households. The survey conducted in 1998 showed that 98.7% of Nigerian households have access to adequately iodised salt at 30 ppm. This finding would suggest that Nigeria, in general terms, has achieved the goal of universal salt iodisation and should now focus its attention on constant monitoring in order to sustain this level of iodisation.

Advocacy as a strategy has been effective in the effort to achieve universal salt iodisation in Nigeria. Not only did it succeed in enlisting the support of the major partners and stakeholders, it also enhanced the good relationship between the salt industries, government regulatory agencies and UNICEF, the donor organisation that played a vital (essentially catalytic) role in the entire process. Capacity building as a strategy, in the private sector, government agencies and non-governmental agencies, also contributed to the success of the programme in Nigeria. Thus, the skill to perform the iodised salt testing was imparted, and equipment and kits for regular measurements and continuous monitoring of salt consumed at the household level were provided. Even the media in general (electronic, print and popular drama) was sufficiently well informed to promote monitoring of salt at the household level, and became strategic allies in the effort to bring about a behavioural change in the Nigerian populace.

The challenge faced today by the Nigerian government, salt industries, the communities and other stakeholders in the IDD elimination drive is to sustain the achievement and consolidate the gains of the universal salt iodisation through certification and monitoring at all levels as a routine by all concerned.

## References

- 1 Stanbury JB. Iodine and human development. *Med. Anthropol.* 1992; **13**: 413–23.
- 2 Hetzel BS, Maberly GF. Iodine. In: Mertz W, ed. *Trace Elements in Human and Animal Nutrition*, Vol. 2, 5th ed. New York: Academic Press, 1986; 139–208.
- 3 Leven HM. Economic dimensions of iodine deficiency disorders. In: Hetzel BS, Dunn JT, Stanbury JB, eds. *The Prevention and Control of Iodine Deficiency Disorders*. Amsterdam: Elsevier, 1987; 195–208.
- 4 Ekpechi OL. Iodine deficiency disorders in Africa. In: Hetzel BS, Dunn JT, Stanbury JB, eds. *The Prevention and Control of Iodine Deficiency Disorders*. Amsterdam: Elsevier, 1987; 291–6.
- 5 Ekpechi OL. Pathogenesis of endemic goitre in Eastern Nigeria. *Print J. Nutr.* 1967; **21**: 537–45.
- 6 Ekpechi OL. Goitrogenic activity of Okoho. *Endocrinol. Exp.* 1973; **7**: 91–6.
- 7 Nwokolo C, Ekpechi OL. New foci of endemic goitre in eastern Nigeria. *Trans. Roy. Soc. Trop. Med. Hyg.* 1996; **60**: 97–108.
- 8 Olurin EO. The fire of life (the thyroid gland). *Inaugural Lectures 1974–1975*. Nigeria: University of Ibadan, 1975.
- 9 Isichei UP, Das S, Egbuta JO, Banwo AI, Norinoto I, Nagataki S. Endemic goitre in Plateau State, Nigeria: the possible aetiological factors and the establishment of endemic goitre map for the region. In: *Proceedings of the Nigeria/ Japan Conference*. University of Jos Press, 1987; 74–9.
- 10 Egbuta JO. Consultancy report on iodine deficiency disorders in Nigeria. Report prepared for UNICEF Nigeria, 1993.
- 11 Egbuta JO, Hettiaratchy N. Nigeria advances toward IDD elimination. *IDD Newsletter* 1996; **12**(4): 29.
- 12 Lantum DN. *Multicentre Study in 7 African Countries to Assess the Impact of Salt Iodisation on the Iodine Status of a Selected Nigerian Population*. Joint WHO/UNICEF/ICCIDD Consultation Report. WHO/AFRO/NUT/97.2. Geneva: World Health Organization, 1996.
- 13 Delange F. The disorders induced by iodine deficiency. *Thyroid* 1994; **4**: 107.
- 14 Delange F, Benker G, Caron P. Thyroid volume and urinary iodine in European school children: standardisation of values for assessment of iodine deficiency. *Eur. J. Endocrinol.* 1997; **136**: 180–3.
- 15 Onyeneke I, Ogbonna A, Ekpechi OL. Consultancy report on impact evaluation of USI in Nigeria. Report prepared for UNICEF Nigeria, March 1999.
- 16 Clemens FW, Wishart JW. A thyroid-blocking agent in the aetiology of endemic goitre. *Metabolism* 1956; **5**: 623.
- 17 Choufoer JC, Van Rhijn M, Kassenaar AAH, Simpson AI. Endemic goitre in western New Guinea. Iodine metabolism in goitrous and non-goitrous subjects. *J. Clin. Endocrinol. Metab.* 1963; **23**: 1203.
- 18 Gaitan E. *Environmental Goitrogenesis*. Boca Raton, FL: CRC Press, 1989.
- 19 Delange F, Iteke FB, Ermans AM. *Nutritional Factors Involved in the Goitrogenic Action of Cassava*. Ottawa: International Development Research Centre, 1982.
- 20 Podoba J, Langer P. *Naturally Occurring Goitrogens and Thyroid Function*. Bratislava: Publishing House of the Slovak Academy of Sciences, 1964.
- 21 Ermans AM, Mbulamoko NM, Delange F, Bourdoux P. *Role of Cassava in the Aetiology of Endemic Goitre and Cretinism*. Ottawa: International Development Research Centre, 1980.
- 22 Langer P, Greer MA. *Antithyroid Substances and Naturally Occurring Goitrogens*. Basel: Karger, 1977.
- 23 Ermans AM, Kinthaert J, Van Der Veldenn, Bourdoux P. Studies of the antithyroid effects of cassava and of thiocyanate in rats. In: Ermans AM, Mbulamoko NM, Delange F, et al. eds. *Role of Cassava in the Aetiology of Endemic Goitre and Cretinism*. Ottawa: International Development Research Centre, 1980; 93.