Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 08, pp.19535-19541, August, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EFFICIENT MODEL FOR THE FLUORIDE EXPOSURE ASSESSMENT THROUGH DRINKING WATER

*Wiem Guissouma and Jamila Tarhouni

Department of Rural Engineering, University of Carthage, National School of Agronomy of Tunis, Tunisia

ARTICLE INFO

Article History:
Received 07th May, 2015
Received in revised form
05th June, 2015
Accepted 26th July, 2015
Published online 31st August, 2015

Key words:
Fluoride, Tap water,
Optimal concentration range,
Hypersensitive population,
Safety limit,
Numerical model.

ABSTRACT

To prevent adverse health effect related to fluoride overdoses in drinking water, a comprehensive study is presented in this work for determining the optimal fluoride concentration range in drinking water. In fact, the optimal concentration range is bordered by two thresholds. For the hyper sensitive age groups (infant and children) the optimal concentration of 0.5mg.L^{-1} is required. This optimal concentration is known as the down threshold. However, for less sensitive age groups (adult), the optimal concentration of 1mg.L^{-1} is taken as the upper threshold. This study proposes also a numerical model to describe the daily fluoride exposure depending on the subject age via drinking tap water. In order to minimize the error between reference values (safety limit) and calculated values;the model is calibrated by means of an algebraic adjustment with introduce a correction factor.

Citation: Wiem Guissouma and Jamila Tarhouni, 2015. "Efficient model for the fluoride exposure assessment through drinking water", *International Journal of Current Research*, 7, (8), 19535-19541.

INTRODUCTION

Fluoride is an ambivalent element, provided with beneficial effects and harm effects to human health (Viswanathan *et al*., 2009). Hence, determining optimal fluoride concentration range seems necessary. This consist the aim of this study. The work presented in this paper is structured as follows; Section 2 presents the used methods to determine the optimal fluoride concentration ranges with respect to subject's age. Section 3 describes results and discussions; it presents also the developed model for the daily fluoride exposure assessment via drinking water (tap water).Then, simulation results will be shown and calibration work of the proposed model will be presented. Finally conclusions and recommendations will be done.

MATERIALS AND METHODS

The hyper sensitive age groups

The determining of the hyper sensitive group is based on a mathematical analysis of the safety margin values for different age groups. The safety margin is calculated by the difference between safety limit and recommended dietary intake (Verkerk, 2010).

****Corresponding author: Wiem Guissouma,***
Department of Rural Engineering, University of Carthage, National School of Agronomy of Tunis, Tunisia.

Optimal fluoride concentrations range

The down threshold of optimal fluoride range

The parameters used to define the down threshold of the optimal range are:references safety limit and recommended dietary intake established by Superior Council for French Public Hygiene and French food safety agency (CSHPF; 1995; AFSSA, 2004).

The upper threshold of optimal fluoride range

The parameters used to define the upper threshold of the optimal fluoride concentration range are:

- The references safety limits (LS) for the different age groups ;
- The tolerable daily intake (TDI). As mentioned by WHO, the expression of (TDI) is given by following equation:
-

$$TDI=\frac{VG\times C_d}{p\times B_w} \qquad \text{.........(Eq.1)}$$

With:

VG: guideline value equal to 1.5 mg / L as established by WHO (WHO, 1994),

C_d: Average daily water consumption (WHO, 2003; Harteman; 1995), p: Percentage of risk attributed to drinking water (80% of fluoride attained the human organism via drinking water),

B_w: Average body weight defined from standard growth curve (Sempé *et al*., 1979).

Modeling the daily exposure to fluoride via drinking water

To model the daily fluoride exposure, the following expression is adopted:

$$ED=\frac{C_F \, x C_d}{C_r} \quad \text{.......(Eq.2)}$$

with

C_F: The fluoride concentration in water expressed in $mg.L^{-1}$,
C_d: The average daily water consumption expressed in $L.d^{-1}$,
C_r: The retention capacity.

Starting from this expression, a numerical model has been developed to determine the daily fluoride exposure with respect to the subject age.This model is then calibrated by means of an algebraic adjustment with introduction of a correction factor.

RESULTS AND DISCUSSION

Determination of the hyper sensitive age groups

Safety margin is age dependent: more the safety margin is low, more the corresponding age group is sensitive and vice versa. This is show in Table 1 which presents referential values of safety limit along with recommended dietary intake.

Table 1. References values of safety limit, recommended dietary intake and the corresponding safety margin

Age	Recommended dietary intake (mg/day) (CSHPF,1995; ARNAUD *et al*., 2001; AFSSA, 2004)	Safety limit (mg/day) (CSHPF;1995; ARNAUD *et al.*, 2001; AFSSA, 2004)	Safety margin (mg/day)
0- 0,5	0,1	0,4	0,4
0.5- 1	0,2	0,5	0,3
1 – 2	0,5	0,7	0,2
2 – 3	0,5	0,7	0,2
3 – 4	0,5	0.7	0,9
4 – 5	1	2,2	1,2
5 - 6	1	2,2	1,2
6 – 8	1	2,2	1,2
8 – 9	1,25	3	1,75
9 – 10	1,5	4	2,5
10 – 11	1,5	4	2,5
11- 13	1,5	4	2,5
13 – 14	1,5	4	2,5
14 – 15	2	4	2
15- 18	2	4	2
>18	2	4	2

A conversion of the tabular data (Table 1) to graphic format is preceded and presented in Figure 1.

Figure 1 shows that; forage groups less than 4years, the safety margin is 12 times lower than age groups more than4years (deviation from $0.2mg.day^{-1}$ to $2.5mg.day^{-1}$). Hence, safety limit analysis can be formulated via two periods:

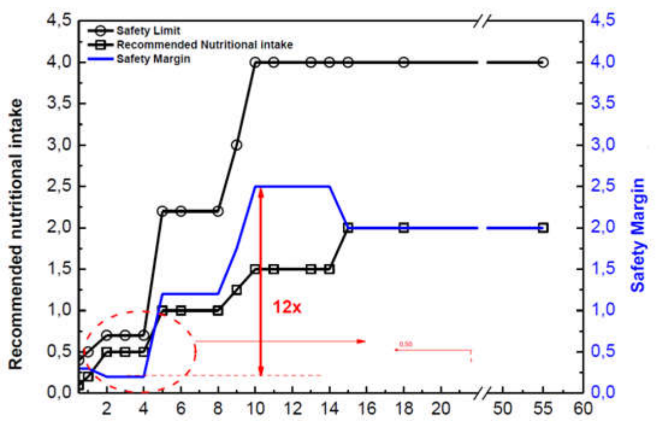

Fig.1. Representative curve of safety limit, recommended dietary intake and safety margin depending on the age

1) The critical period: during this period, safety margin is significantly reduced ($0.2mg.day^{-1}$) to meet requirement of safety limit and allows dietary intake. So, age groups lower than 4years are considered as hyper sensitive population to deficiency and excess fluoride intake (infants and young children less than 4years). This period is considered to be the period of tooth enamel formation and bone tissue formation. In fact; the excessive fluoride intake during tooth formation can develop of dental fluorosis (Manitoba Water Stewardship and Manitoba Health, 2011). In the other hand, the incorporation of fluorine occurs in bone tissue in being formed. So the excessive fluoride intake can develop skeletal fluorosis (Dhar, 2009).
2) The post-critical period: during this phase, the safety margin becomes larger than the critical period which allows meeting safety limit requirement and recommended dietary intake. So the age groups upper than 4years are considered as relatively less sensitive than infants and young children less than 4years.

Determination of the optimal fluoride concentrations

The optimal concentration cannot be determined by a single value but is defined by range values bordered by two thresholds. The down threshold is estimated for the hypersensitive populations (0 to 4 years) and the upper threshold is addicted for populations aged more than 4 years.

Determination of the down threshold of optimal fluoride concentrations range

For the hypersensitive population (0-4 years); Table 1 present two values that can be discussed to meet the recommended dietary intake and safety limit. The first value is $0.4mg.d^{-1}$: It meets to safety limit requirement for age groups (less than 4years) but in three over a total of five cases the recommended dietary intake is not respected. The second value is $0.5mg.d^{-1}$: it corresponds to the recommended dietary intake for age groups less than 4 years, but for infants less than six months, the safety limit is slightly exceeded (0.4 mg.d-1). For these babies' population, the global public health recommends that they should be feed with milk from their mother breast (WHO, 2003). Consequently, the water consumption will be reduced and safety limit becomes respected. Therefore, the fluoride daily intake of 0.5mg.d^{-1} is chosen as an optimal daily intake for the hypersensitive population.

The ratio between the optimal fluoride daily intake previously defined (0.5mg.d^{-1}) and the daily water consumption established by WHO (1L.d^{-1} for children) is used to calculate the optimal fluoride concentration (C_{op}) as follow:

$$Cop = \frac{\text{optimal fluoride daily intake}}{\text{average daily water consumption}} \quad \text{.......(Eq.3)}$$

The C_{op} obtained is 0.5mg.L^{-1} considered as the down threshold of optimal fluoride concentration range

Determination of the upper threshold of optimal fluoride range

Two parameters presented in following table (Table 2) are used to define the upper threshold of the optimum fluoride concentration range. The first parameter is the referential safety limit which is presented in Table 1. The second parameter is the tolerable daily intake (TDI) calculated by means of (Eq.1).

This concentration is considered to be the upper threshold of optimal fluoride concentration range mainly adopted for age groups more than 4years.

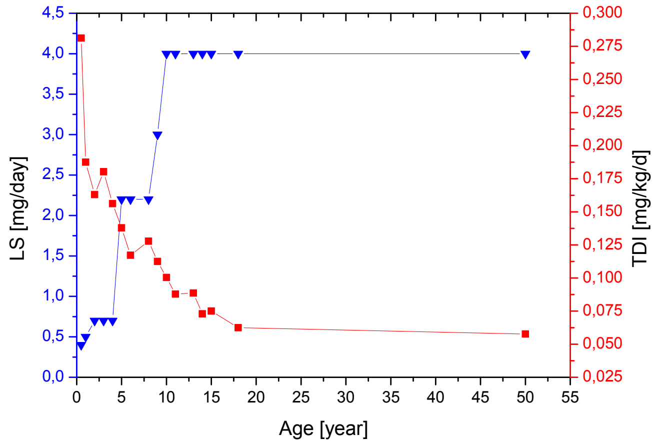

Fig.2. Variation of Tolerable Daily Intake (TDI) and Safety Limit (LS) according to subject age

Table 1. Summary data of the subject age groups

Ages group classification	Daily water consumption 'Cd' (L)	Average body weight 'Bw' (+)	calculated TDI	Safety limit mg.day^{-1}
0-6 months	0.75	5	0.281	0.4
6-12 months	1	10	0.188	0.5
1-2 years	1	11.5	0.163	0.7
2-3 years	1.25	13	0.180	0.7
3-4 years	1.25	15	0.156	0.7
4-5 years	1.25	18	0.130	2.2
5-6 years	1.25	20	0.117	2.2
6-8 years	1.5	22	0.128	2.2
8-9 years	1.5	25	0.113	3
9-10 years	1.5	28	0.100	4
10-11 years	1.5	32	0.088	4
11-13 years	1.75	37	0.089	4
13-14 years	1.75	45	0.073	4
14-15 years	2	50	0.075	4
15-18 years	2	60	0.063	4
>18 years	2	65	0.058	4

Determination of the upper threshold of optimal fluoride range

Two parameters are used to define the upper threshold of the optimum fluoride concentration range. The first parameter is the reference safety limits which are presented in Table 2. The second parameter is the tolerable daily intake (TDI) calculated. The method which has been adopted to define the upper threshold of the optimal fluoride range is to define first the optimal daily intake which has been considered to be in equilibrium with safety limit. The equilibrium position is identified by the intersection point between tolerable daily intake (TDI) curve and safety limit (LS) curve as it is presented in Figure 2.

According to Figure 2 the point of intersection of the two curves (LS and TDI) defines the equilibrium point between the benefits and risks of fluoride. Through an orthogonal projection on the TDI curve an optimal daily intake of 0.14mg.kg-1.bw.day-1 is proposed in children age scaling from 4 to 5years. An optimal fluoride concentration of 1mg.L^{-1} is calculated by adopting the Canadian approach to building the minimum fluoride concentration without health risks (Table 3).

This indicated value (upper threshold) is the bench mark value of the Canadian study (Health Canada, 1996) and WHO that has defined in warm climate. The optimal fluoride concentration in drinking water should be lower than 1mg.L-1 and 1.2mg.L-1 for hot and cool climate respectively (Armfield JM; 2010).

Based on this analysis and after identification of the optimal fluoride concentration range (down and upper threshold), drinking water must contain optimal fluoride concentration ranging from 0.5mg.L^{-1} to 1mg.L^{-1}.

Modeling the daily exposure to fluoride

Content in drinking water

This section will present the development of a numerical model describing the daily exposure to fluoride content in drinking water. It should be noted, that individuals may be affected differently (even same dose or concentration), and the same person may react differently depending on their age and state of health. Many physiological factors can help explain this individual variability as:

- Age: sensitivity to the toxic effects is different in infants, young children and the elderly,
- Gender: female or male,
- Nutritional status: toxicity may be influenced by the mass of adipose tissue, dehydration, vitamin deficiencies,
- Pregnancy: it produces changes in the metabolic activity of the body and thus a formation of xenobiotic during pregnancy,
- The health state: healthy individuals are more resistant because they metabolize and eliminate toxic more easily than those with liver damage or kidney.

Table 3. Summary of fluoride retention coefficients depending on the age

Age groups (years)	population aged less than 4 years 4 years	population aged more than 4 years
Coefficient of retention(C_r)	0.9	0.5

Parameter 2: The daily water consumption for different age groups (Cd)

This parameter is obtained from Table 2 which presents the daily water consumption depending on the subject age.

Table 2. Identification of the optimal fluoride concentration not causing health risk

Study	Type baseline value referenced	referenced value (mg.kg^{-1}.day^{-1})	drinking water Proportion (L)	Population	body weight (Kg)	Water consumption (L.day^{-})^{1}	Obtained value (mg.L^{-1})
Health Canada1996	DJT	0.122	50%	22 to 26 months	13	0.8	1
This work	DJT	0.140 (FIG. 2)	50%	4-5 years (FIG. 2)	18 (Tab. 2)	1.25 (Tab. 2)	1

Knowledge of the interaction of all these factors and many other aspects remains incomplete. Indeed, it is often difficult to evaluate the sensitivity of an individual or population and to predict what the biological response of the body after exposure to a toxin.

To overcome the lack of knowledge about certain aspects and interactions of all the physiological factors, a predictive model must be developed to predict a rapid and accurate biological evolution of the human body after exposure to fluorine ions (FAO/WHO, 2006). In this section, we describe the model developed to predict the daily exposure based on the subject age.

3.1. Numerical model's parameters

The following is a listing of the different parameters involved in the model development.

Parameter 1: The capacity retention of fluoride in the human bodyCr

The amount of fluoride retained in the body is age dependent. More fluoride is retained in young bones than in the bones of older adults (Horowitz HS. 1996). This parameter is age-dependent. According to the European Food Safety Authority 50-90% of ingested fluoride accumulates in the human body; "The fluoride is not essential for growth or human development. The fluoride is ingested in part retained in the bone and partly excreted mainly via the kidneys (Becker, 2005). For babies and young children who have not yet developed kidney, the retention of fluoride attained 90% of the absorbed dose (Table 4).

Conventionally, infants and young children are considered as population aged less than 4years. For healthy adults, the kidneys excrete approximately 50% of the ingested dose of fluoride; the retention is 50% or less (Table 4) (EFSA, 2005).

Parameter 3: The concentration of fluoride in water CF

This parameter is used to calculate the daily fluoride exposure (ED) as it is given by the following equation:

$$ED=\frac{C_F\, x C_d}{C_r} \quad \text{... ....(Eq.4)}$$

By substituting this parameter (CF) with the optimal fluoride concentration (C_{OP}), the following equation becomes:

$$LS=\frac{C_{OP}\, x C_d}{C_r} \quad \text{........(Eq.5)}$$

where LS presents the safety limit.

As it is mentioned in the previous sub-sections, Cop is fixed at 0.5mg.L^{-1} for subject aged less than 4years and at 1mg.L^{-1} for those aged more than 4years. The calculation results are summarized in Table 5.

Table 4. Summary of Optimal fluoride concentration (C_{op}) value based on age

Age groups (years)	Age < 4 years	Age> 4 years
Optimal Fluoride Concentration C_{op} (mg.L^{-1})	0.5	1

Table 6 presents the values of model parameters and reference values that have been adopted for calibration of the numerical model. The obtained results (calculated LS) and the recommended referential values were plotted together in Figure 3 in order to evaluate the reliability of the model. This figure shows a gap between the calculated LS (Eq.5) and the referential LS (CSHPF;1995; ARNAUD; 2001; AFSSA;2004) for age categories less than 14years. Beyond 14 years we consider that the proposed model is accurate and the obtained values are with a good agreement compared to the referential values.

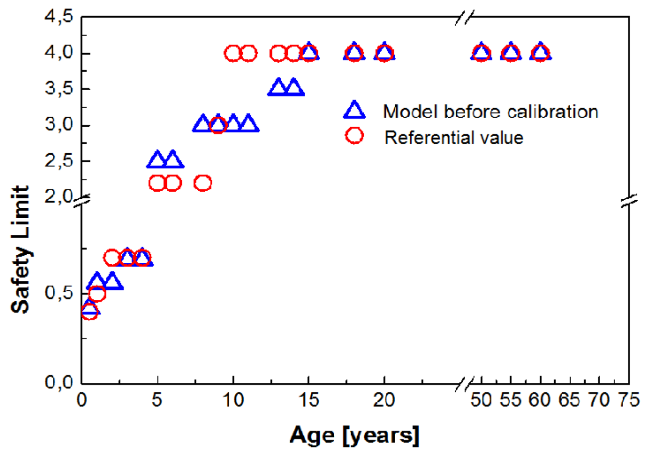

Figure 3. The calculated LS and referential LS in function of age

Thus, the proposed model should be calibrated to be more consistent. To calibrate this model, a calibration method based on two different intervals is used.

Interval 1: Category less than 14years of age

Figure 4 shows the evolution of the correction factor (fac1) according to age. This factor is calculated as follows:

$$fac1 = \frac{LS_{referential}}{LS_{calculated}} \qquad \text{..................(Eq.6)}$$

A corrective function FC1 is obtained via function fac1 value'sfitting. It has a 7th order polynomial form as mentioned in (Eq. 7).

$$FC1 = \sum^{7} (a^{i} \times age^{i}) + C \qquad \text{............(Eq.7)}$$

Interval 2: Category age over 14years

In this interval, the LS is equal to the referential LS (fixed value equal to 4mg.L^{-1}). Thus, the adopted corrective function FC2 is equal to unit (FC2=1).

Complete solution

To have a valid full corrective function for all age groups, a smoothing function FSMO is subsequently used to link the two partial corrective functions (FC1 and FC2). This is a common technique in mathematical modeling and it basically role is to ensure good accuracy of the final numerical model. In our case, as shown in Figure 4, this smoothing function is equal to 1 in the interval 1 (age categories less than 14years) and 0 elsewhere i.e. the interval 2 (age categories over 14 years). It is expressed by the following mathematical expression form:

$$f_{SMO} = \frac{1}{1+e^{(10^{2}(age-14))}} \qquad \text{.............(Eq.8)}$$

It links both calibrations partial functions FC1 and FC2 to achieve complete corrective function as follows:

$$FC = FC1 \times f_{SMO} + FC2 \times (1 - f_{SMO}) \qquad \text{..............(Eq.9)}$$

Thus, one can establish the new LS after calibration as follows:

$$LS_{calibrated} = \left[LS_{Calculated} \frac{C_{op}\, x C_j}{C_r} \right] \times FC \qquad \text{........(Eq.10)}$$

Figure 5 shows a comparison between the reference LS and the LS calculated before and after calibration. It is found that after this calibration work, the absolute error relative to the reference value is minimized for the different age groups. Indeed, this error was 36% for the age of 8years and became 16% (Figure 6). For 5yearsaged subject, the error was 13% before calibration and becomes almost zero after calibration.

Figure 5 presents a good agreement between calculated LS after calibration and referential LS which validates the established model for estimating the optimal fluoride concentration not causing health risk. Hence, this model can predict the following toxicity parameters:

Table 5. List of the model parameters and the reference values

New Age Groups	C_r	C_{op}	Daily water consumption ($L.day^{-1}$)	Calculated Safety Limit ($mg.day^{-1}$)	Reference Safety Limit ($mg.day^{-1}$) CSHPF, 1995, ARNAUD, 2001; AFSSA, 2004)
0-6 months	0.9	0.5	0.75	0.42	0.4
6-12 months	0.9	0.5	1	0.56	0.5
1-2 years	0.9	0.5	1	0.56	0.7
2-3 years	0.9	0.5	1.25	0.69	0.7
3-4 years	0.9	0.5	1.25	0.69	0.7
4-5 years	0.5	1	1.25	2.5	2.2
5-6 years	0.5	1	1.25	2.5	2.2
6-8 years	0.5	1	1.5	3	2.2
8-9 years	0.5	1	1.5	3	3
9-10 years	0.5	1	1.5	3	4
10-11 years	0.5	1	1.5	3	4
11-13 years	0.5	1	1.75	3.5	4
13-14 years	0.5	1	1.75	3.5	4
14-15 years	0.5	1	2	4	4
15-18 years	0.5	1	2	4	4
>18 years	0.5	1	2	4	4

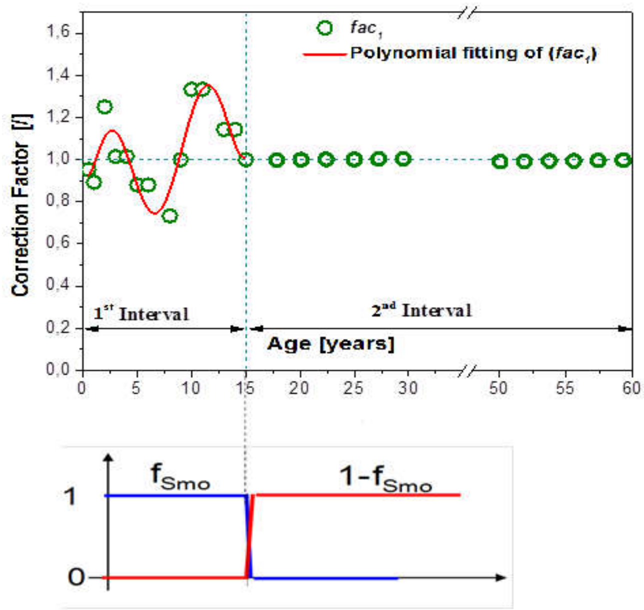

Figure 4. Evolution calculated LS and reference LS according to age (top) and smoothing function corresponding (bottom)

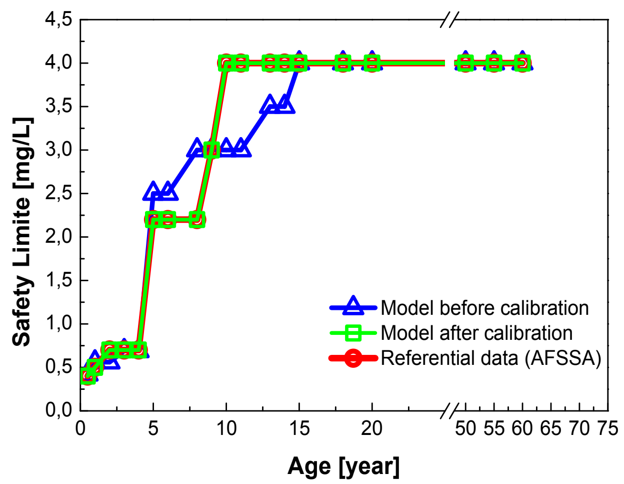

Figure 4. Comparison of referential LS (red circles-line curve) with modeled LS before calibration (bleu tringles-line curve) and after calibration (green square-line curve)

- The value of fluoride safety limit for the specific populations (pregnant women, people suffering from an acute or chronic renal failure ... etc.) by introducing a retention capacity parameter (Cr) and a daily water consumption parameter (Cd) which a relative variation according to the climate change.
- The daily fluoride exposure through drinking water by the following formula:
-

$$ED=\frac{C_F\times C_d}{C_r}\times\left[\left[\sum_{i=1}^{7}\left(a^i\times age^i\right)+C\right]\times\frac{1}{1+\exp\left(10^2(age-14)\right)}+\left(1-\frac{1}{1+\exp\left(10^2(age-14)\right)}\right)\right]$$ ....(Eq.11)

According to the abovementioned equation we consider subject age less than 14 years

$$ED=\frac{C_F\times C_d}{C_r}\times\left[\left[\sum_{i=1}^{7}\left(a^i\times age^i\right)+C\right]\right]$$ ... ...(Eq.12)

And for a subject age over 14 years, we adopt the following expression:

$$ED=\frac{C_F\times C_d}{C_r}+1$$ ....(Eq.13)

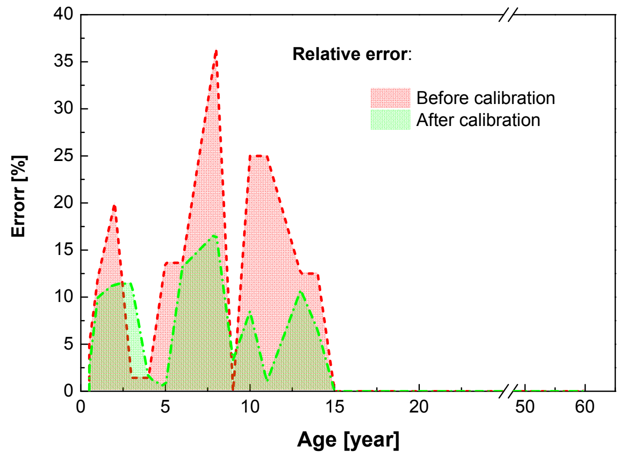

Figure 5. Relative error between modeled Safely Limit and referential Safety Limit before (red filled curve) and after calibration (green filled curve)

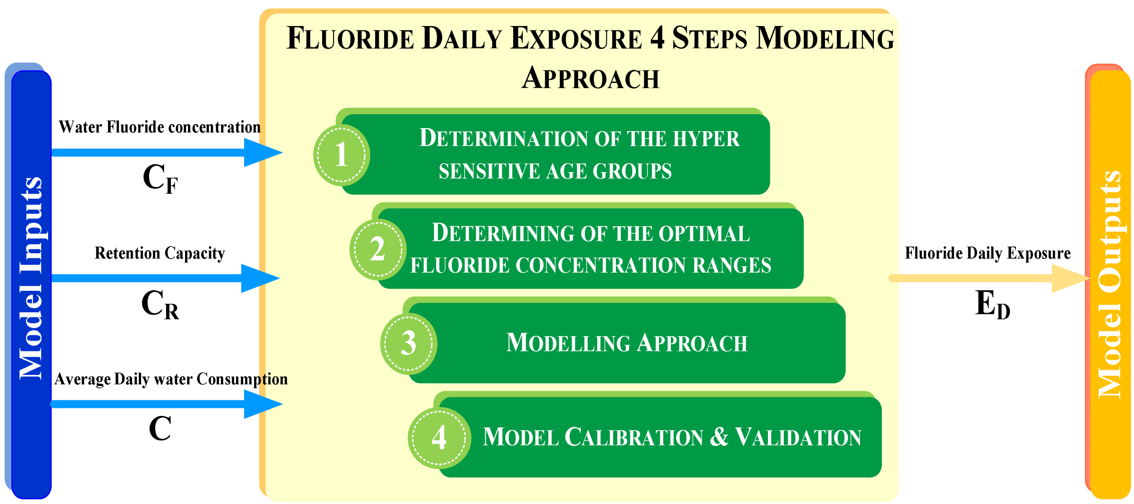

Figure 3. Fluoride daily exposure 4 steps modelling approach

Finally, Figure 7 presents the fluoride daily exposure 4 steps modelling approach and the corresponding input and output parameters.

Conclusion

It is well established that prolonged use of fluoride at recommended levels does not produce any harmful physiological effects in the human. However, there are safe limits for fluoride beyond which harmful effects can occur. These effects can be classified as acute and chronic toxicity.
This study we allowed to conclude that:

1. Fluoride is an ambivalent element, with beneficial effects in moderate intake and harmful effects on human health by excessive and prolonged intake.
2. The Thresholds of the health effects of fluoride are defined as follows:

   a) The down threshold which the optimum concentration of the beneficial effect of fluoride on dental health is $0.5 mg.L^{-1}$.
   b) The upper threshold which the optimal concentration of fluoride does not cause health Risks is 1mg. L-1.

What makes the drinking water must contain optimum fluoride concentration ranging from $0.5 mg.L^{-1}$ to $1 mg.L^{-1}$.

Numerical model was developed and calibrated in comparison to referential values. This model will later provide the value of the safety limit of fluoride for special populations (pregnant women, people with conditions such as renal failure ... etc.) and calculate the daily exposure of fluoride through drinking water.

Acknowledgement

The authors thank the Tunisian National Agency of Sanitary and Environmental Control Products (ANCSEP - Tunisia) for further discussions and useful information.

REFERENCES

AFSSA 2004 (No. Afssa – Saisine n° 2004 - SA - 0210), 2004. Maisons - Alfort, Paris, France.
ANCSEP – Tunisia - http://www.ancsep.rns.tn/ accessed on 25/07/2015
Armfield JM. 2010. Community effectiveness of public water fluoridation in reducing children's dental disease. *Public Health Rep.,* 2010 Sep-Oct; 125(5) : 655-64
ARNAUD, J., MARTIN, A., 2001. Apports nutritionnels conseillés pour la population française. Fluor – In 171–172.
Becker, W., 2005. Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies (NDA) on a request from the Commission related to the Tolerable Upper Intake Level of Fluoride. EFSA Panel Diet. Prod. Nutr. Allerg. NDA.
CSHPF, 1995Avis sur les limites de sécurité dans les consommations alimentaires des vitamines et de certains minéraux,
Dhar V, Bhatnagar M. 2009: Physiology and toxicity of fluoride. *Indian J Dent Res*., 20:350-5
EFSA - European Food safety authority; 2005, Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission related to the Tolerable Upper Intake Level of Fluoride, (Request N° EFSA-Q-2003-018), (adopted on 22 February 2005, *The EFSA Journal,* (2005) 192, 1-65.
FAO/WHO, 2006. A Model for Establishing Upper Levels of Intake for Nutrients and related Substances. Report of ajoint FAO/WHO technical workshop 2005. World Health Organization, Rome.
Hartemann P. 1995. Contribution à la réflexion sur la fixation d'une CMA pour le plomb dans l'eau de distribution publique. Journée Italo-franco-suisse, Mulhouse.
Hathcock J. and Kriengsinyos W. 2011; Highest Observed Intake: definition, regulatory uses and provisional values.
Horowitz HS. 1996. The effectiveness of community water fluoridation in the United States. *J Public Health Dent*., 56:253- 8.
Manitoba et Santé Manitoba, 2011. Gestion des ressources hydriques. La présence de fluorure dans les sources d'approvisionnement en eau au Manitoba.
Sempé, M., Pédron, G., Roy-Pernot, M.P., 1979. Auxologie méthode et séquences. Théraplix. Paris.
Verkerk, RH. 2010. The paradox of overlapping micronutrient risks and benefits obligates risk/benefit analysis. Toxicology, 2010 Nov 28; 278(1):27-38. Epub 2010 Feb 24
Viswanathan G., Jaswanth A, Gopalakrishnan S, Siva Ilango S, Aditya G. 2009: Determining the optimal fluoride concentration in drinking water for fluoride endemic regions in South India. Department of Pharmaceutical Chemistry, Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli - 627012, Tamil Nadu, India
WHO | Rapport sur la santé dans le monde 1994 dossier de presse, 1994. Genève.
WHO | Rapport sur la santé dans le monde, 2003 – façonner l'avenir, n.d.
WHO | Rapport sur la santé dans le monde, 2004 – changer le cours de l'histoire, n.d.
WHO | Stratégie mondiale pour l'alimentation du nourrisson et du jeune enfant, 2003, Genève.

****