2013 International Nuclear Atlantic Conference - INAC 2013
Recife, PE, Brazil, November 24-29, 2013
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: 978-85-99141-05-2

ASSESSMENT OF ^{210}Pb CONCENTRATION IN *Nicotiana tabacum* L., BURLEY VARIETY, CULTIVATED IN BRAZIL

Rique J. F. X. Rocha [1], *Carolina F. Silva [2], Jonatan V. Frujuele [3], Raquel R. Bovolini [4], Sandra R. Damatto [5]

[1,2,3,4,5] Laboratório de Radiometria Ambiental
Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
[1]rjrocha@ipen.br
[2]cfsilva@ipen.br
[3]jonatanfrujuele@hotmail.com
[4]ra_bovolini@yahoo.com.br
[5]damatto@ipen.br

ABSTRACT

Tobacco products are extensively used throughout the world and the most consumed are cigarettes, cigars and narghile. The damaging effects that these products cause to human health are discussed worldwide and many researches are performed with the aim of relating the use of these products with various diseases. Brazil is the largest exporter and second largest producer of tobacco worldwide, according to the crop year 2009/2010 production. The tobacco plant (*Nicotiana tabacum* L.) is used to manufacture all derivatives and the chemical composition of the resulting tobacco varies with the type of tobacco leaves, how they are grown, the region where they are cultivated, the characteristics of preparation and the temperature variations resulting from the tobacco incomplete combustion. There is lack of information about the chemical and radiological characterization of the tobacco plant both in international and Brazilian literature. Thus a project was stablished with the objectives of characterizing chemically and radiologicaly the three varieties most cultivated in Brazil of *Nicotiana tobacum* L., Virginia, Burley and Common; this paper presents the preliminary results of ^{210}Pb concentrations for the Burley variety. Plants from this variety were cultivated in pots with organic substrate and fertilizer and in a small farm in natural conditions. The entire plant was analyzed, the organic substrates, the fertilizers and the soil. The results obtained presented higher values for ^{210}Pb in leaves when compared with the other parts of the plant. Comparing the three study areas the highest results of ^{210}Pb concentration were obtained in the plants cultivated in the urban area probably due to its atmospheric deposition.

1. INTRODUCTION

The tobacco derivatives are the most consumed and sold products in the world (more than 1.2 billion people are consumers), as for example, cigarette, cigar and narghilé [1, 2]. Among these products the cigarette stands out, because it is the most consumed and can be considered one of the most lucrative products in the world, providing higher profits for the manufacturer.

The damage effects which theses products cause to human health has been intensely discussed and many researches are constantly conducted in the world relating the use of the tobacco derivates with a great variety of diseases [1, 3-10].

Tobacco plant (*Nicotiana tabacum* L.) is used in the manufacture of all derivate products and the smoke chemical composition varies with each kind of tobacco leaf, how they are grown, the source region, the characteristics of preparation (compression, filter and paper) and temperature variations from the tobacco incomplete combustion [2]. Nicotine, a stimulant effect substance, is extracted from the tobacco plant along with over 4000 toxic chemical substances. The smoke generated by burning tobacco is composed of these toxic substances such as carbon monoxide, carbon dioxide, nitrogen oxides, ammonia, volatile nitrosamides, hydrogen cyanide, volatile compounds that contain sulfur, volatile hydrocarbons, alcohols, aldehydes, ketones, As, Ni, Cd, radioactive substances such as ^{210}Pb and ^{210}Po, nicotine and tar particles [2, 11-13].

Brazil is the second largest producer of tobacco and the largest exporter in the world since 1993, thanks to the product's quality and integrity. Tobacco cultivation in Brazil is a relevant agricultural activity and 95% is concentrated in the southern region of Brazil, in the states of Rio Grande do Sul, Santa Catarina and Paraná where the responsible factories for the manufacture of cigarettes in Brazil are found. The remaining 5% of the crop is produced in the states of Bahia and Alagoas, where are located the cigar factories. The varieties of *Nicotiana tabacum* L. most cultivated in Brazil are Virginia, Burley and Common [2, 14].

There are in the international and national literature many papers about radiological and chemical characterization of cigarettes, but a few papers about this same characterization of the *Nicotiana tabacum* L. plants and there is lack of information about this characterization in all varieties of tobacco grown in Brazil.

Therefore the objective of this paper is to present preliminary results of ^{210}Pb concentration in the tobacco plant *Nicotiana tabacum* L., Burley variety, which is cultivated in Brazil and used in cigarette production. The analytical technique employed was total beta counting after radiochemical separation and measured in a low background gas flow proportional detector [15].

2. MATERIAL AND METHODS

2.1. Cultivation of *Nicotiana tabacum* L.

Pb-210 concentration was determined in Burley variety cultivated at IPEN (23°33'59.24"S 46°44'15.63"W) that is located far from industrial pollution or traffic of cars and in other two different areas, one located in a urban area in the city of São Paulo (23°36'00.31"S 46°30'13.18"W) and another in a rural area, in the city of Sarapuí, São Paulo (23°38'25.43"S 47°29'34.15"W). The seeds were acquired from cooperative's tobacco farmers in Santa Catarina, the state responsible for growing this variety. They were sown in suitable trays containing organic substrate and adding once a week nitrogen, phosphorus and potassium based fertilizer, N, P, K, in the proportion of 20:10:20.

When the plants reached 25 to 30 cm in height, the plants that were cultivated at IPEN and urban area were transferred to larger pots containing also organic substrate. The plants from IPEN were fertilized daily and the urban area once a week with based fertilizer NPK in the proportion of 20:20:20, where they remained until the harvest time. For the rural area the plants were planted in the soil region, without the addition of fertilizers.

In no time of cultivation, herbicides or insecticides were added. After harvest the plants were taken to the laboratory to ^{210}Pb determination.

2.2. Pre-treatment of samples

The roots, the stems and the leaves from the plants, as well as, the substrate and the soil from the rural area, the fertilizers used at IPEN and the substrate *in natura*, were all analyzed. All the parts of the plant, the substrates, the fertilizers and soil were dried in an oven for 48 h at 50^{o}C. After this procedure the samples were macerated and pulverized in a glass mortar.

The leaves were harvested as they are used in the cigarette production, FIG. 1, that is, separating them according with the plant height. These divisions are called, in the tobacco industry, as “baixeira”, “semimeeira”, “meeira” and “ponteira”.

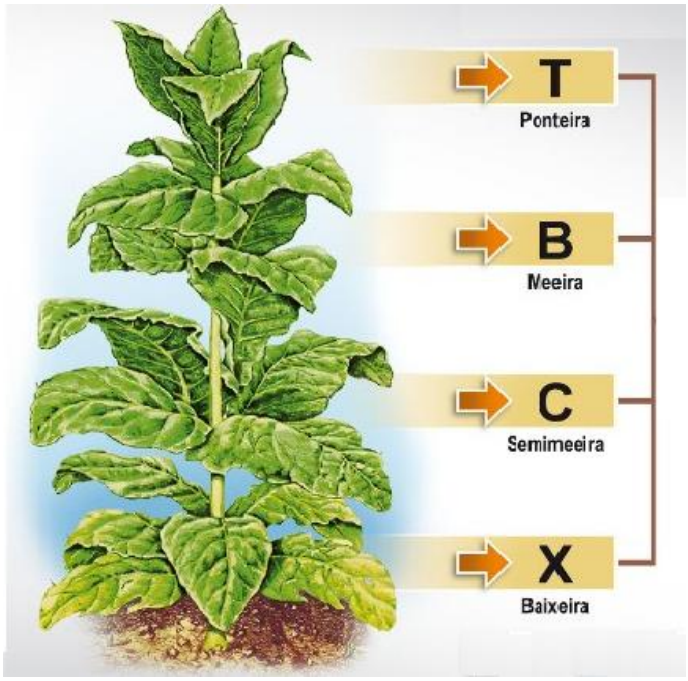

Figure 1: Classification of *Nicotiana tabacum* L. leaves used in national cigarette production [16].

2.3. ^{210}Pb determination

The samples were solubilized in a microwave digestor or heating plate with mineral acids, concentrated HNO_3 and 40% HF and also 30% H_2O_2 to eliminate the organic matter. ^{210}Pb concentration was determined by radiochemical procedure that consists of an initial precipitation of Pb with 3M H_2SO_4, dissolution of the precipitate with nitrilo-tri-acetic acid at basic pH, and precipitation of $^{210}PbCrO_4$ with 30% sodium chromate. The ^{210}Pb concentration was determined through its decay product, ^{210}Bi, by measuring the gross beta activity of the $^{210}PbCrO_4$ precipitate. The chemical yields were determined by gravimetric analysis. ^{210}Pb

was determined in a low background gas flow proportional detector; the methodology detection limit is 4.9 mBq g^{-1} [15].

3. RESULTS AND DISCUSSION

Plants were harvested after six months of growth in the three areas of study. FIG. 2, 3 and 4 presents the results obtained of ^{210}Pb concentration (mBq.g^{-1}) in the plants grown at IPEN, the urban and rural area including the substrates and the soil. The two fertilizers used in the cultivation were also analyzed and the results obtained for ^{210}Pb concentration were below the methodology detection limit of 4.9 mBq g^{-1}.

Comparing the results obtained for the entire plant in the three areas where the plants were cultivated, the one that presented higher concentrations of ^{210}Pb was the urban area, probably due to atmospheric deposition of ^{210}Pb [17].

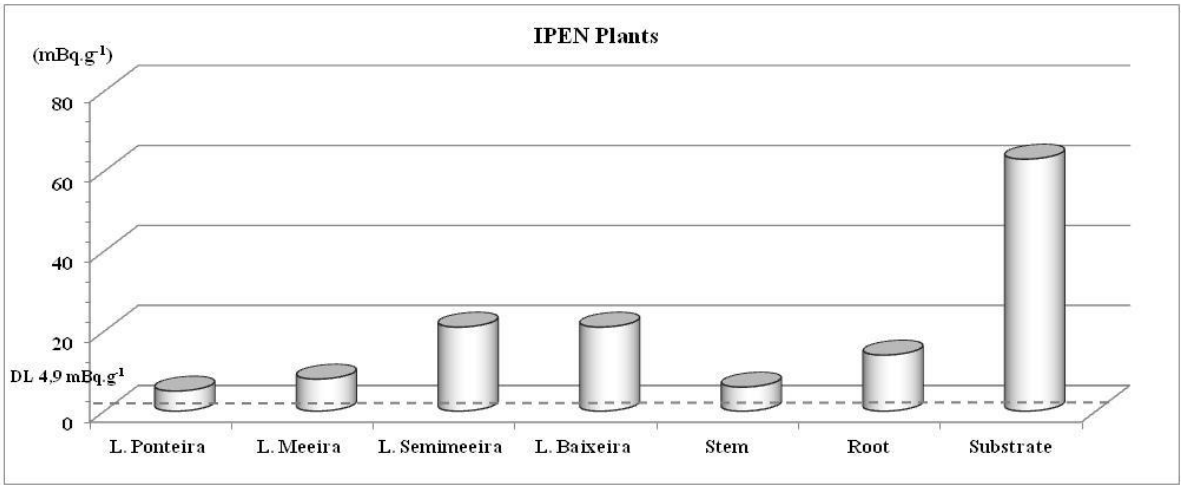

Figure 2: ^{210}Pb concentrations (mBq.g^{-1}) in plants grown at IPEN.

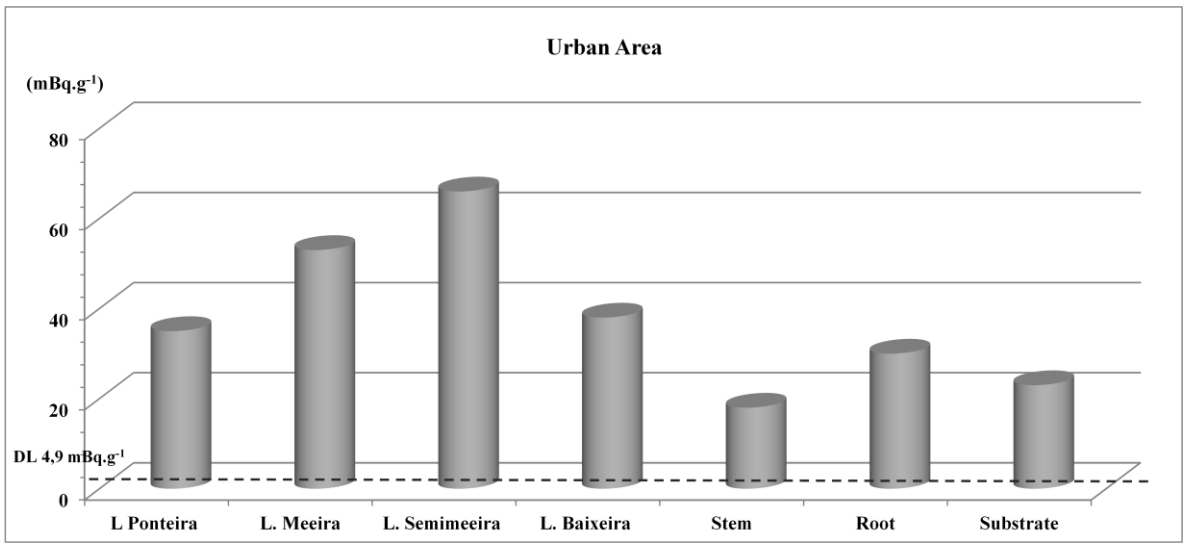

Figure 3 - ^{210}Pb concentrations (mBq.g^{-1}) in plants grown in the urban area.

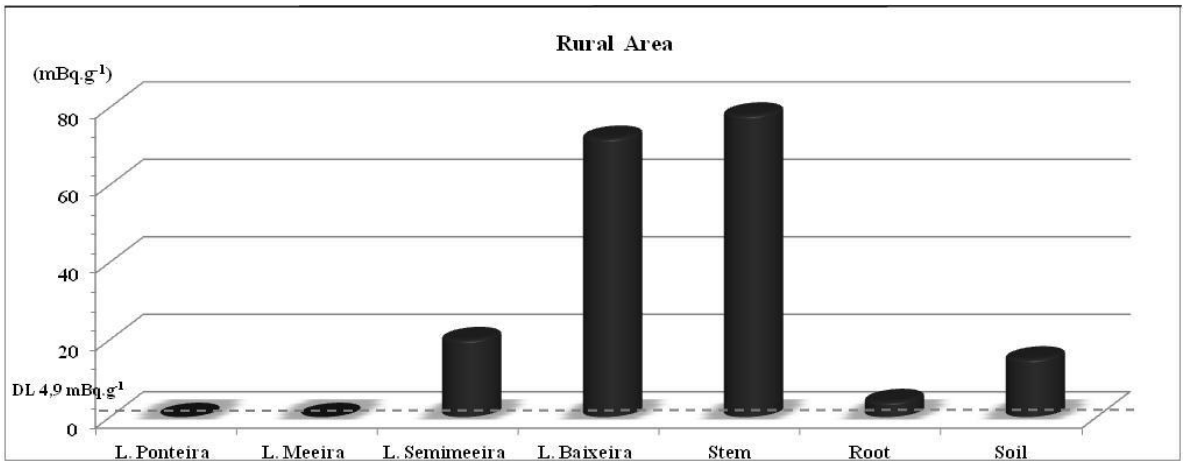

Figure 4 - Concentrations of ^{210}Pb (mBq.g^{-1}) in plants grown in the rural area.

FIG. 5 presents the ^{210}Pb concentration (mBq.g^{-1}) results for the leaves in the three studied areas. The urban area leaves showed the highest radionuclide concentration, comproving the deposition of ^{210}Pb from the atmosphere, except for "baixeira" leaves from rural area that presented higher values.

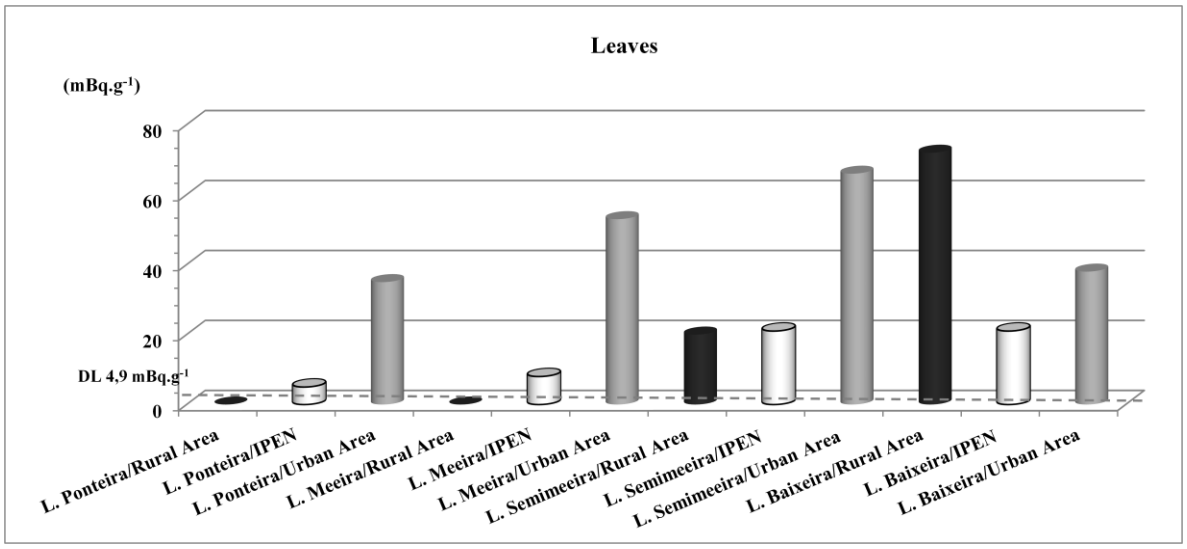

Figure 5: ^{210}Pb Concentration (mBq.g^{-1}) in the leaves from plants grown in urban, rural and IPEN area.

In a similar work, Savidou et al. [17] found a mean concentration of 13.4 mBq g^{-1} of ^{210}Pb in tobacco leaves cultivated in different regions of Greece and in the present work it was found 28.3 mBq g^{-1}. This result obtained for the tobacco cultivated in Brazil is in accordance with a previus study where ^{210}Pb concentration was determined in cigarette tobacco produced in Brazil that ranged from 11.9 to 30.2 mBq g^{-1} [18].

FIG. 6 presents the ^{210}Pb concentration results in the stem and roots of plants from the three study areas. The results for the urban area showed the highest values, except for stem from rural area that presented higher value, in spite of the roots having presented the lowest values.

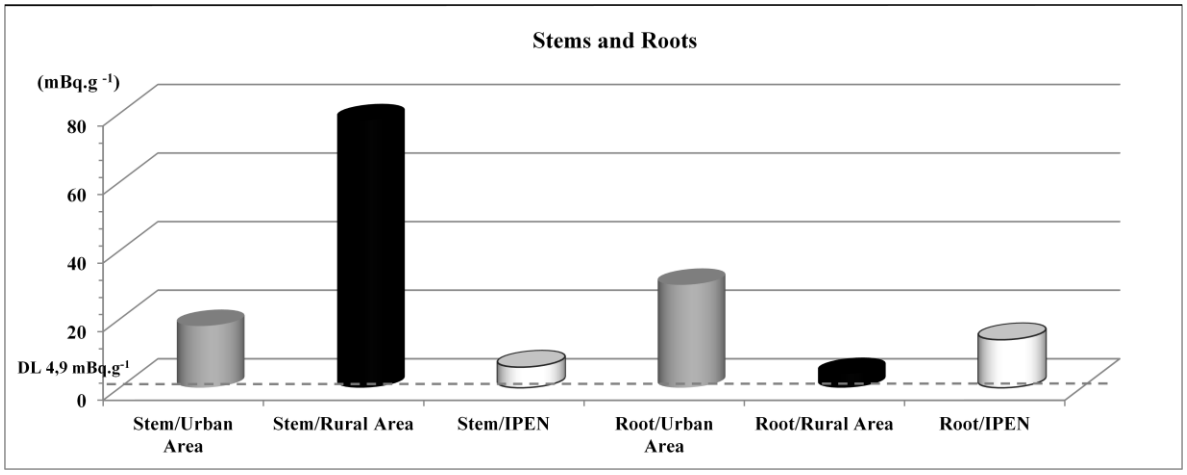

Figure 6: ^{210}Pb concentration (mBq.g^{-1}) in the stems and roots grown in urban, rural and IPEN area.

FIG. 7 presents the ^{210}Pb concentration results in the substrates and soil from the three study areas, including the substrate *in natura*. The highest value obtained was for the IPEN substrate, due probably to the daily fertilizer addition, in spite of the concentrations of ^{210}Pb being below the detection limit for the two fertilizers used. The substrate from urban area presented lower values of ^{210}Pb concentration than the substrate in natura, caused probably by the ^{210}Pb absortion by the plant.

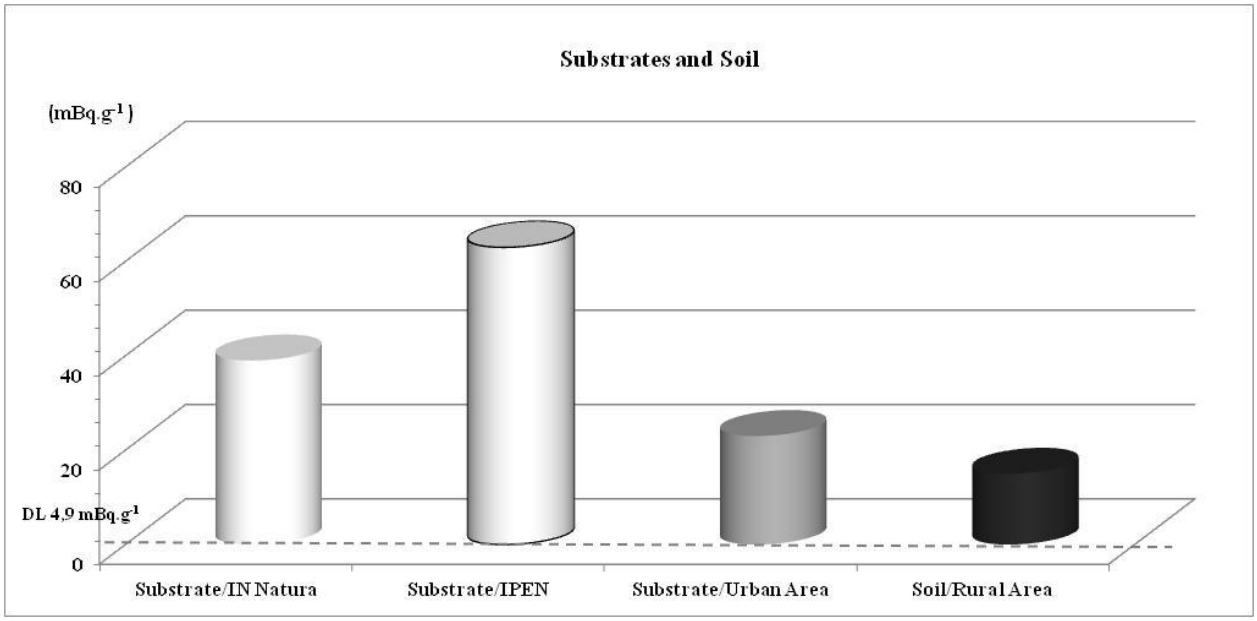

Figure 7: ^{210}Pb concentration (mBq.g^{-1}) in the substrates and soil from plants grown in urban, rural and IPEN area.

4. CONCLUSIONS

This paper presented the preliminary results of ^{210}Pb concentration in *Nicotiana tabacum* L., Burley variety, used in the Brazilian cigarette production. Plants were cultivated at IPEN and in an urban area in the city of São Paulo in pots containing organic substrate and fertilizer based on NPK, as well as, in the soil of a rural area, in the city of Sarapui, São Paulo.

The highest results of ^{210}Pb concentration were obtained in the plants cultivated in the urban area probably due to its atmospheric deposition. The results obtained were compared with results from international literature and they showed that the Brazilian tobacco has higher values, but they are in agreement with a previous work that analyzed ^{210}Pb in Brazilian cigarette.

The preliminary results obtained in this paper can contribute with the better knowledge and undestanding of ^{210}Pb behavior found in *Nicotiana tabacum* L., Burley variety, cultivated in Brazil, since Brazil is the largest exporter of tobacco in the world.

ACKNOWLEDGMENTS

The authors acknowledge the significant assistance received from the agronomists L. H. Damatto and T. Savaris in cultivating the tobacco plants and Ms. M. J. Oliveira by the plant cultivation in the city of Sarapui, SP. This project was supported by Comissão Nacional de Energia Nuclear MSc. grant and by Conselho Nacional de Pesquisa e Desenvolvimento Tecnológico - CNPq, Scientific Iniciation Grant n° 156121/2012-3.

REFERENCES

1. E. M. Khater, N. S. Abd El-Aziz, H. A. Al-Sewaidan, K. Chaouachi, "Radiological hazards of Narghile (hookah, shisha, goza) smoking: activity concentrations and dose assessment," *J. Environ. Radioactivity*, **99**, pp.1808–1814 (2008).
2. V. M. Prata, E. S. Emídio, H. D. Dórea, "Aplicação de métodos quimiométricos na caracterização de charutos utilizando extração por dispersão da matriz em fase sólida e análise por cromatografia gasosa acoplada à espectrometria de massas," *Quim. Nova,* **34**, pp.1, 53-58, (2011).
3. J. M. Albandar, C. F. Streckfus, M. R. Adesanya, D. M. Winn, "Cigar, pipe, and cigarette smoking as risk factors for periodontal disease and tooth loss," *J. Periodontol,* **7**, pp.1874-1881, (2000).
4. M. V. Djordjevic, S. D. Stellman, E. Zang, "Doses of nicotine and lung carcinogens delivered to cigarette smokers," *J. National Cancer Inst*., **92**, pp.106-111, (2000).
5. S. J. Henley, M. J. Thun, A. Chao, E. E. Calle, "Association between exclusive pipe smoking and mortality from cancer and other disesses," *J. National Cancer Inst*., **96**, pp.853-861, (2004).
6. O. M. Dias, E. R. Turato, "Cigarette smokers' views on their habit and the causes of their illness following lung cancer diagnosis: a clinical-qualitative study," *Sao Paulo Med. J*., **124**, pp.125-129, (2006).

7. M. Underner, I. Maes, T. Urban, J. C. Meurice, “Effets du tabac sur la maladie parodontale. Rev Mal Respir,” **26**, pp.1057-73, (2009).
8. H. Ben Saada, “Le narguilé et ses effets sur la santé. Partie I: Le narguilé, description générale et proprieties” *Revue de Pneumologie Clinique*., **65**, pp.369-375, (2009).
9. D. W. Moeller, L-S. C. Sun, “Chemical and radioactive carcinogens in cigarettes: associated health impact and responses of the tabacco industry, U.S. congress, and Federal Regulatory Agencies” *Healthy Physics*, **99**, pp.674-679, (2010).
10. Y. Arnson, Y. Shoenfeld, H. Amital, “Effects of tobacco smoke on immunity, inflammation and autoimmunity,” *Journal of Autoimmunity*, **34**, pp.258-265, (2010).
11. Skwarzec, J. Ulatowski, D. I. Struminska, A. Borylo, “Inhalation of ^{210}Po and ^{210}Pb from cigarette smokingin Poland. J. Environ. Radioactivity,” **57**, pp.221–230, (2001).
12. G. H. Cunha, A. R. C. Jorge, M. M. F. Fonteles, F. C. F. Sousa, G. S. B. Viana, S. M. M. Vasconcelos, “Nicotina e tabagismo,” *REPM*, **1**, pp.1-10, (2007).
13. A. A. Viegas, “Formas não habituais de uso do tabaco,” *J. Bras Pneumol*, **34**, pp.1069-1073, (2008).
14. “Sindicato das indústrias do fumo” www.sindifumo.com.br (2011).
15. S. R. Damatto, L. Leonardo, B. P. Mazzilli, “Monitoring anthropogenic airborne ^{210}Pb and ^{210}Po in the vicinity of a TENORM industry using lichen as bio-indicator. In: International Topical Conference on Po and Radioactive Pb isotopes, 2009, Seville,” *Proceedings of the International Topical Conference on Po and Radioactive Pb isotopes*, (2009).
16. “Sindicato Interestadual da Indústria do Tabaco – Sinditabaco,” http://sinditabaco.com.br/sobre-o-setor/tipos-de-tabaco/ (2011).
17. A. Savidou, K. Kehagia, K. Eleftheriadis, “Concentration levels of ^{210}Pb and ^{210}Po in dry tobacco leaves in Greece,” *J. Environ. Radioactivity*, **85**, pp.94-102, (2005).
18. A. C. Peres and G. Hiromoto, “Evaluation of ^{210}Pb and ^{210}Po in cigarette tobacco produced in Brasil”, *J. Environ. Radioactivity*, **62**, pp.115-119, (2005).