2011 International Nuclear Atlantic Conference - INAC 2011
Belo Horizonte,MG, Brazil, October 24-28, 2011
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: **978-85-99141-04-5**

EVALUATION OF BROWN AND GOLDEN FLAXSEED *(Linum usitatissimum* L.*)* BY EDXRF

Márcia L. de Oliveira[1] , Ana Claudia S. Oliveira[1], Valter Arthur[2] and Eduardo Almeida[3]

[1] Instituto de Pesquisas Energéticas Nucleares
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
mlageoli@usp.br

[2] Centro de Energia Nuclear na Agricultura
Departamento de Radiobiologia e Ambiente
Av. Centenário, 303 – Caixa Postal 96
13416-000 Piracicaba, SP
arthur@cena.usp.br

[3] Centro de Energia Nuclear na Agricultura
Departamento de Instrumentação Nuclear
Av. Centenário, 303 – Caixa Postal 96
13416-000 Piracicaba, SP
edualm@cena.usp.br

Abstract

Flaxseed is one of the most important oilseed crops since all of its parts can be utilized in its pure and/or processed version. Whereas it stem consists of good quality fiber which has high strength and durability, it can be the main base for the textile, paint, animal and human food industry. The seed provides oil that is one of the richest sources of α-linolenic acid (ALA) and lignans. Besides, flaxseed is an essential source of high quality protein and soluble fiber and is a potencially source of phenolic compounds. These properties enable the emergency of flaxseed as an important functional food ingredient. Therefore, the aim of this study is to quantify some of the different chemical elements in brown and golden flaxseed by EDXRF, to compare them and to analyze the results with the flaxseed values of TACO project (Brazilian Table of Food Composition). In order to know the difference between the chemical elements presented in two varieties of flaxseed, EDXRF (Energy Dispersive X-Ray Fluorescence) technique was applied. This technique is versatile, fast and nondestructive enabling the researchers to recognize some chemical elements and quantify them in real time, it also enables the achievement of detection limits up to 0.002% (20 ppm). The results evidence that the contents of potassium, calcium, zinc, manganese, iron and bromine are present in flaxseed as expected when compared to TACO Table.

1. INTRODUCTION

Among functional foods, flax (*Linum usitatissimum L.*) is recognized as a major source of essential fatty acids w_3 and w_6. It also holds various nutrients such as fiber and phenolic compounds, known to exert antioxidant activity [4]. Flaxseed is becoming popular due to their functional role on health care which stimulates domestic production of the seed as raw material. Furthermore, the emerging market for natural products coupled with consumer interest in disease prevention has pushed the food industry in the quest for healthy products, targeting research in this direction.

It is valid to enphasize that the term flaxseed and linseed are often used interchangeably. Flaxseed is used to describe flax when eaten by humans while linseed is used to describe flax when itis used for industrial purposes [5]. Flaxseed is the seed of flax, whose fibers are traditionally used to make fabrics.It is commonly found as whole grain, ground or in the form of oil. Regarding the composition of nutrients, flaxseed presents 28% dietary fiber, 41% lipids and 21% protein, 3% ash, and its oil contains vitamins A, B, D and E, minerals and amino acids [5].

Knowledge of the composition of food consumed in Brazil is fundamental in order to achieve food security in the country. Tables of food composition are basic pillars for nutrition education, quality control and food safety assessment as well as adequacy of nutrient intake for individuals or populations. The TACO project (Brazilian Table of Food Composition), coordinated by the Center for Studies and Research in Food (NEPA) of UNICAMP and with funding from the Ministry of Health (MOH and Ministry of Social Development and Fight against Hunger), is an initiative to provide data from a large number of nutrients in national and regional food obtained through representative sampling and analysis performed by laboratories with analytical skills demonstrated by interlaboratory studies, according to international criteria [3].

In Brazil only two types of flax are commercialized, the golden and brown ones. Knowing the difference between the chemical elements present in both varieties the technique used was EDXRF (X-Ray Fluorescence Energy Difference).

As mentioned above, the aim of this study is to quantify some of the different chemical elements in brown and golden flaxseed by EDXRF, compare them with each other and to the Table TACO flaxseed in order to

2.MATERIALS AND METHODS

2.1. Digestion of the samples

The two kinds of flaxseed were purchased from the Piracicaba market (State of São Paulo, Brazil). They are freeze dried and 500 mg of each sample were digested in an open system, using 6 ml HNO_3 p.a. (65% v/v). The temperature was gradually increased to 130 ºC and then H_2O_2 p.a. (30% v/v) was added to sample until the solution becomes colorless, and the final

volume was brought up to 10 ml with deionized water (Ward, 1980). The digestion procedure was carried out in triplicate.

2.2. Preparation of standards and samples for analysis by EDXRF

This procedure was based on a work described previsously [1]. However, the sample volume pipetted on the Mylar film was 100 mL and the concentration of Ga was 10.25 mg/L. This element was used as internal standard. Analyses of samples and standards were performed in triplicate using an Energy Dispersive X-ray Fluorescence equipment (Shimadzu, EDX-720 model).

3. RESULTS AND DISCUSSION

Table 1 presents the average of the results with the deviation standard. The validation of the method was made with the standards of the IAEA-361 (International Atomic Energy Agency) for soybean flour. This table 1 also shows the library data given by IAEA. Readings obtained for Potassium, Calcium, Manganese, Iron, Copper, Zinc and Bromine by EDXRF.

Table 1 – Readings by EDXRF for Brown, Golden Flaxseed and Soybean flour in mg/100g

	Brown Flaxseed		Golden Flaxseed		IAEA-361 (soybean flour) library.		IAEA-361 (soybean flour)·	
	Average	Dev st	Average	Dev st	Average	dev	Average	dev
K	790	30	740	60	1860	140	1821	137
Ca	229	16	230	30	169	6	225	34
Mn	2,53	0,15	3,5	0,4	3,4	0,5	3,54	0,37
Fe	4,7	0,8	5,9	0,7	7,6	1,8	18,2	7,7
Cu	2,89	0,18	2,7	0,3	2,1	0,03	1,29	0,15
Zn	4,71	0,19	4,9	0,4	3,4	0,13	3,64	0,32
Br	nd	nd	nd	nd	0	0	-	-

According to Table 1 the Golden Flaxseed has more manganese and iron than the Brown, and both have more copper and zinc than the soyflour which was used as standards. The readings of soybean are compatible with the library data of soybean from IAEA.

The Table 2 presents the values of TACO Table for the same chemical elements of Table 1 and the average values obtained by EDXRF in mg/100g.

Table 2 - Table for TACO flaxseed and readings of EDXRF in mg/100g.

	TACO	Brown	Golden
K	869	790	740
Ca	211	229	230
Mn	2,81	2,53	3,5
Fe	4,7	4,7	5,9
Cu	1,09	2,89	2,7
Zn	4,4	4,71	4,9
Br	nd	nd	nd

The values for K, Ca, Mn, Fe, Zn are compatible with the TACO Table [3]; the values of Brown and Golden Flaxseed for Cu have higher values, which leads us to search forlikely contaminants.

In the search for greater functionality of foods, the EDXRF technique fits perfectly, bringing knowledge of the quantities of each chemical element with better precision, making it easier to prescribe in cases of deficiencies of them.

4. CONCLUSIONS

We observed also that the methodology used to detect mineral elements was efficient when compared with standards.The EDXRF technique was efficient to quantify the chemicals in question. The final values are consistent with TACO Table.

5. REFERENCES

1. ALMEIDA, E. ; TAVARES, G. A. ; BENDASSOLLI, J. A. ; NASCIMENTO FILHO, V. F. . Determination of Cr, Fe, Co, Ni, Cu, Zn, As and Pb in liquid chemical waste by energy dispersive X-ray fluorescence. Journal of Radioanalytical and Nuclear Chemistry (Print), v. 287, p. 351-355, 2011.

2. WARD, A.F.; MARCIELLO, L.F.; CARRARA, L.; LUCIANO, V.J. Simultaneous determination of major, minor, and trace elements in agriculture and biological samples by inductively coupled argon plasma spectrometry. Spectroscopy Letters, **v.13**, p.803-831 (1980).

3. UNICAMP. Tabela de Composição dos alimentos (2006). http://www.unicamp.br/nepa/taco/tabela (2011).

4. MAYES, P.A. Lipids of physiological importance. In: Harper. Biochemistry. 7th ed. São Paulo: Athena, p.142-154 (1994).

5. Flax Council of Canada. www.flaxcouncil.ca (2011).

Author to be contacted: Marcia Lage de Oliveira - (IPEN / USP) - São Paulo / SP – e-mail. mlageoli@usp.br