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Thermal Characterization of the Favelone Oil (*Cnidoscolus phyllacanthus*)

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Abstract: A thermal analysis has been applied to characterization of oil and fats. Taking into account the problems of desertification and agricultural practices able to provide income to the population at the semi-arid region of Northeastern Brazil, this work presents the results of the thermal characterization by thermogravimetry and differential scanning calorimetry of the favelone seed oil (*cnidoscolus phyllacanthus*).

Key words: Favelone, cnidoscolus phyllacanthus, thermal analysis, thermogravimetry, semi-arid

INTRODUCTION

The cnidoscolus phyllacanthus species, locally known as favelone, deserves its prominence, among of the other plants of this region, due to its resistance to the dry environment and its scattering over a remarkable area of the semi-arid region of Northeastern Brazilian. Consequently, there is the potential of huge amounts of raw material, for the extraction process of the oil and flour by industries. Other factor of great importance is the local of occurrence of the favelone: in semi-arid lands of low fertility, which present small interest for an economical exploitation of the existing cultures (Lima, 1986).

Previous studies indicate a good perspective for the utilization of these materials as human and animal food and thus, the possibility of their industrialization (Lima, 1986; Duque, 1980).

Therefore, this work aims at characterizing the favelone seed oils, in terms of their thermal properties (TG/DSC), with the purpose of the application of these materials as an alternative for human and animal food.

MATERIALS AND METHODS

The seeds of favelone were collected in experimental unities of EMBRAPA (Brazilian governmental organization for agriculture research) of various regions of the Paraíba state, Brazil. The favelone seed oil was extracted according to the procedure used by Ahmad *et al.* (1988) and its analysis regarding the fatty acid composition was carried out according to the methodology of AOCS, American Oil Chemists Society (1994).

The TG/DTG curves were obtained with the purpose of studying the thermal stability. It was used a thermobalance (Shimadzu, TGA-50), under air atmosphere (30 mL min^{-1}), using an alumina crucible, in non-isothermal conditions. The TG/DTG curves were obtained using a sample mass of 10.00.5 mg, heating rate of 10°C min^{-1}, at the 25-800°C temperature range.

The DSC curves were determined with the objective of studying the enthalpic transitions regarding the thermal decomposition of the favelone seed oil, under nitrogen atmosphere (50 mL min^{-1}). A differential scanning calorimeter (Shimadzu, DSC-50) was employed, operating at the temperature range from room temperature up to 500°C, with a heating rate of 10°C min^{-1}. From the DSC data, were determined the specific heat capacities of the favelone seed oil. Such DSC data were obtained from DSC curves performed both for the investigated samples and for alumina, the reference material.

The calculations of specific heat were based on implementation of the temperature program. The oil samples were heated at a rate of 5°C min^{-1} up to 30°C during 5 min. Then, they were heated at a rate of 10°C min^{-1} up to 150°C during five minutes. The following ratio was used to calculate the heat capacities:

$$c = \frac{m_0 c_0}{m} \cdot \frac{S_3 - S_1}{S_2 - S_1} \quad (1)$$

where c_0 and c are the specific heat of the reference material and of the favelone oil, respectively; m_0 and m refer to the mass of reference material and the favelone oil samples, respectively and S_1, S_2 and S_3 are the thermal displacements of the DSC in relation to the blank, reference and sample, respectively (Kasprzycka-Guttmann and Odzeniak, 1991; Santos and Souza, 2006).

RESULTS AND DISCUSSION

The thermogravimetric behavior of the favelone seed oil (Fig. 1) displays three decomposition steps between 220-550°C, indicating a high stability, when compared with other edible vegetable oils (Santos *et al.*, 2004).

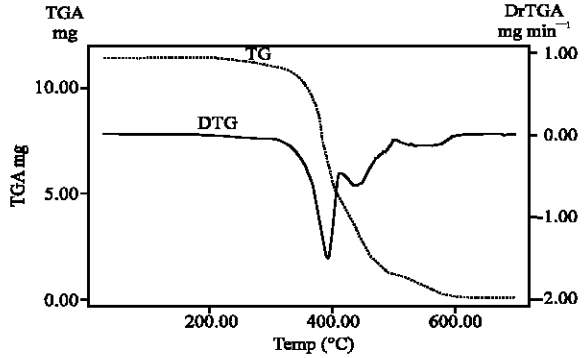

Fig. 1: TG/DTG curves of the favelone seed oil

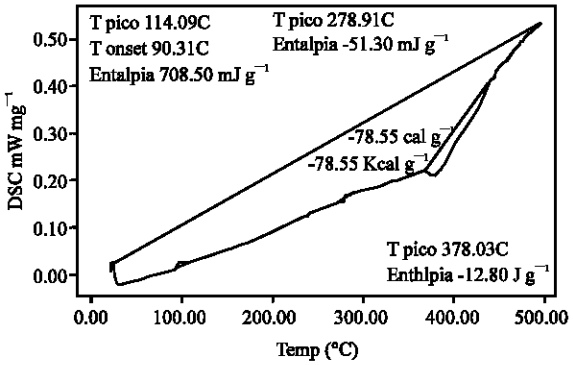

Fig. 2: DSC curve of the favelone seed oil

Table 1: Thermogravimetric data of the favelone seed oil

1st step		2nd step		3rd step	
Peak Temperature (°C)	Mass loss	Peak Temperature (°C)	Mass loss	Peak Temperature (°C)	Mass loss
385.2	59.5	446.0	30.9	547.9	9.5

Table 2: Specific heat capacities of the favelone seed oil

Cp (J/g°C)				
40°C	60°C	80°C	100°C	120°C
1.625	1.689	1.702	1.806	1.834

Table 1 contains the TG/DTG data of the analyzed samples. The favelone seed oil presented three thermal decomposition steps between 90 and 500°C, indicating high thermal and oxidative stabilities, when compared with other edible vegetable oils (Santos *et al*., 2002).

The oil sample presented an exothermic event with a peak temperature of 115°C, corresponding to its oxidation. The other two events correspond to the decomposition of its constituents.

The DSC curves of the favelone seed oil presented different profiles, in which can be observed endothermic transitions, (Fig. 2), corresponding to the decomposition of their principal constituents (lipids).

From the total integration of DSC curves for the thermal decomposition process of the favelone seed oil at the 25-500°C range, can be estimated their mean calorific values (cal g^{-1}). The values obtained were 75.6. These values are similar to the ones of other foods utilized for human use (Santos *et al*., 2004).

The specific heat capacities of liquid phase (oil) samples were determined according to the previously described method. The specific heat capacity values of the favelone seed oil are listed in Table 2. For most of the samples, the specific heat capacity values did not substantially vary as a function of temperature.

CONCLUSION

The study of the thermal analytical properties of the favelone seed oil contributes to a better understanding of the probable chemical changes of these materials when exposed to high temperatures. According to the herein described results, the favelone seed oil present thermodynamic properties similar to the ones of other foods utilized for human use, as well as an acceptable calorific value.

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