Asian Journal of Chemistry; *Vol. 24, No. 5 (2012), 1952-1954*

ASIAN JOURNAL OF CHEMISTRY

www.asianjournalofchemistry.co.in

Kinetic Study of Cumin Essential Oil and of its Major Components

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(*Received*: 23 March 2011; *Accepted*: 5 December 2011) AJC-10801

Cumin (*Cuminum cyminum* linn.) is an annual plant of the Umbellifereae family. It has been used for a very long time in traditional medicine in the treatment of diarrhoea, dyspepsia and gastric disorder. In present work we have carried out the extraction of the Algerian essential oil of cumin using the hydrodistillation method. This extraction was followed by a kinetic study of the constituents yield of the cumin essential oil following a given time. The essential oil has been analyzed following the capillary gas-chromatography coupled with mass spectrometry. The achieved results allowed to identify the major components of our essential oil and to determine their yield following the extraction duration.

Key Words: *Cuminum cyminum* L., Essential oil, Water distillation, Kinetic extraction.

INTRODUCTION

In general, essential oils present a very complex and variable mixtures in their composition. The cumin seed samples were collected in Algeria (high plateaus). To determine the composition percentage of this essential oil[1], we used the capillary gas-chromatography coupled with mass spectrometry[2,3]. In this work, our objective is to optimize the yield and the composition of cumin essential oil during extraction by water distillation.

EXPERIMENTAL

Plant material and isolation process: In present study, the water distillation of the dried and pulverized dry cumin fruit was carried for about 270 min using a Clevenger type apparatus following the method recommended by the European Pharmacopoeia[4]. In order to eliminate the water from our essential oil sample, we used anhydrous magnesium sulphate, which we stored at 4 ºC in the dark.

Identification of oil components: The essential poil samples gathered were subjected to a chromatographic coupled with a mass spectrometry analysis using a GC 17A Shimadzu type chromatograph coupled with a mass spectrometer Shimazu QP 5000. The treatment of the data was carried with the help of a data bank called NIST 12.LIB and NIST62.LIB

The analysis operatory conditions by GC-MS are described as follows:

Column

Stationary phase	95 % polydimethylsiloxane 5 % phenyl
Nature	PTE -5
Length	30 M
Inside diameter	0.25 mm

Temperature

Injector	250 ºC
Detector	280 ºC
Column	70 ºC (5 min) to 220 ºC (15 min) at the rate of 2 ºC per min

Vector Gas

Vector gas	helium
Flow	0.9 mL/min

Programming time

Time	95 mn
Injected volume	0.2 µL

Mass spectrometer parameters

Mass interval (mass range) from MZ = 30.00 until MZ = 400.00
Detector (volts detector) (KV) 1.50
Detector type quadripolar electronic impact

For the identification of the essential oil components, we relied on the mass spectrum and the retention clues[5,6] as data basis comparing them to literature.

RESULTS AND DISCUSSION

Evolution of cumin essential oil yield as a function of time: The results presented in Fig. 1, show that for a relatively long duration of treatment (270 min), we have been able to reach the stage representing equilibrium. Since we are dealing with easily accessible endogenous deposits for vapour. It was noted that 96 % of the essential oil was recovered after only 2 h. And it would not be economically advantageous to prolong the extraction under these conditions beyond 2 h.

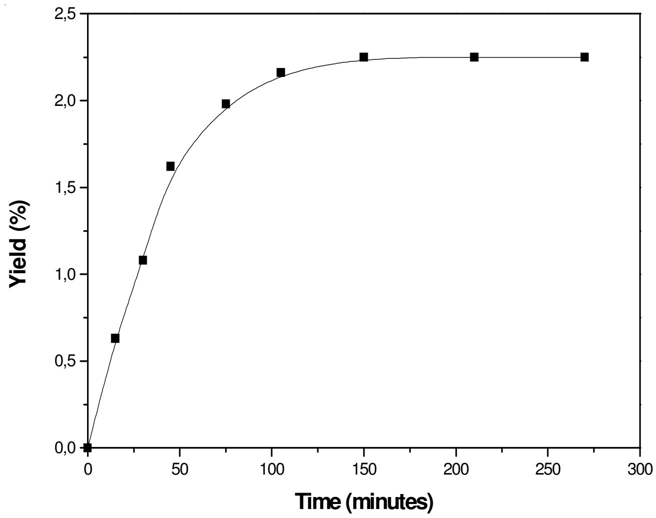

Fig. 1. Evolution of cumin essential oil yield according to the water distillation duration

Evolution of the major components yield of cumin essential oil according to the extraction duration: The (GC/MS) chromatographic analyses has allowed to identify the components of present sample and confirm its composition when comparing their mass spectra to those stored in the MS database and with mass spectra literature data[7]. Previous work showed that the cumin essential oil can contain up to 53 % monoterpenes and 3 % sesquiterpenes and up to 43 % of the oxygenated compounds of the oil content[8]. These analyses (GC/MS) were carried out on the various samples recovered during the kinetic study.

Our Algerian essential oil is basically composed of aldehyde (40 %) and 1-phenyl 1,2-ethanediol, (27.8 %). Concerning quantity, a result which complies with literature. Other representative components of the oil were identified. Like *p*-cymene (7.4 %), myrtenal (11.2 %), β-pinene (5 %), γ-terpinene (5.2 %). The yield evolution of the different components of the essential oil are represented in the following Figs. 2-6.

The curves present two type forms. One corresponds to two principal components (cumin aldehyd and the 1 phenyl-1,2-ethanediol), which are extracted in the first 2 h of the treatment and the other corresponds to the minor components, which are extracted after a longer treatment. These results are explained by the fact that the major components are localized in endogenous sites which are easily accessible with steam, which explains the quick exhaustion of the component deposits after 2 h extraction compared to the other components.

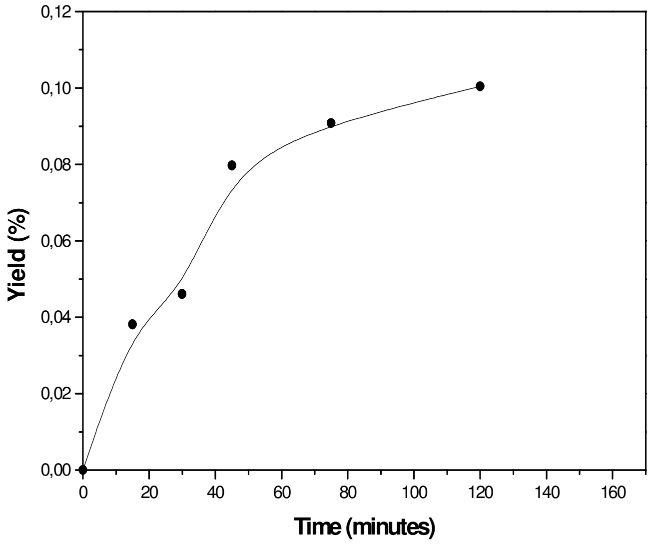

Fig. 2. β-Pinene yield evolution according to the treatment duration

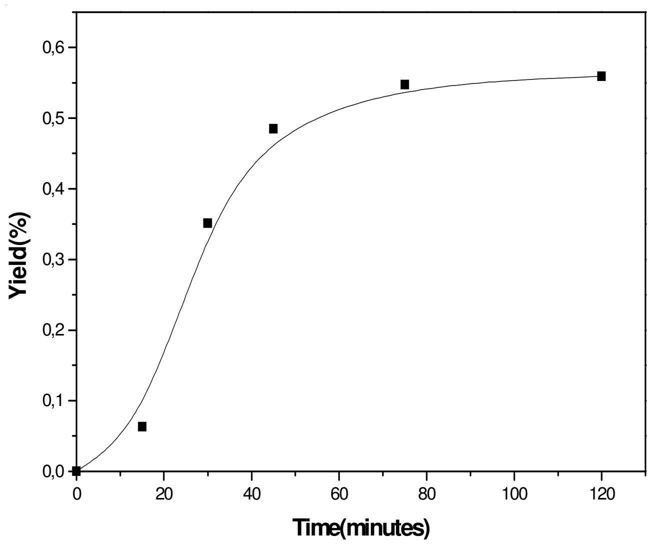

Fig. 3. Cuminaldehyde yield evolution according to the treatment duration

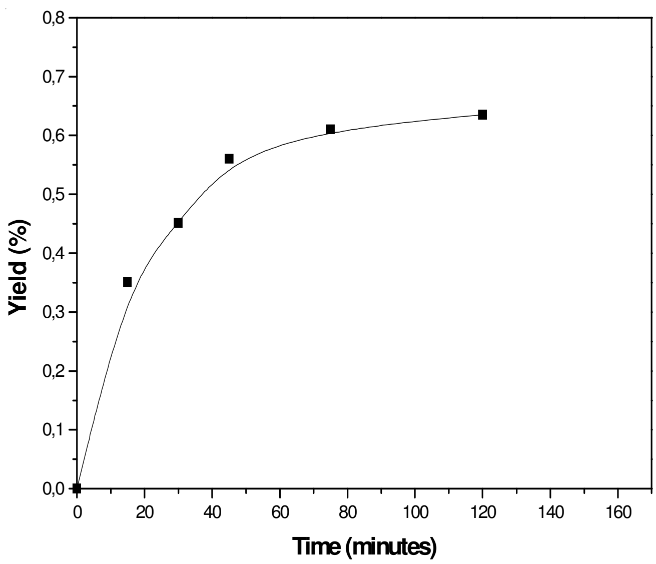

Fig. 4. 1-Phenyl-1,2-ethanediol yield evolution according to the treatment duration

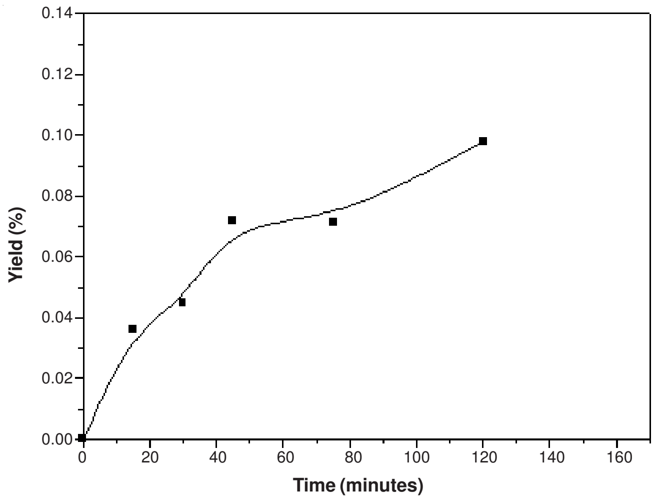

Fig. 5. *p*-Cymene yield evolution according to the treatment duration

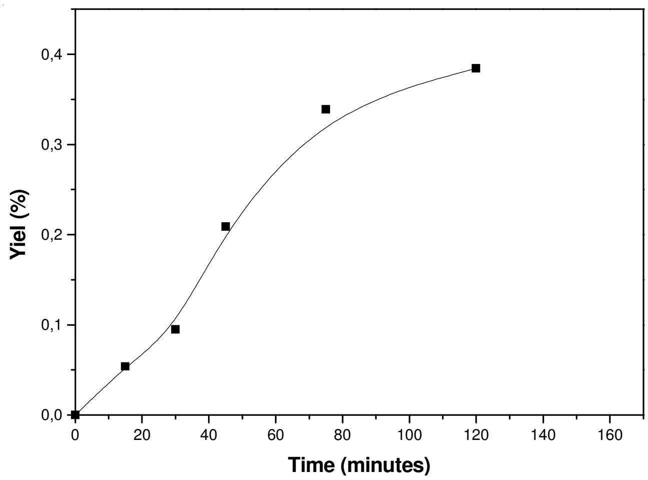

Fig. 6. Myrtenal yield evolution according to the treatment duration

Conclusion

Because of its importance and use in the making of different medicines for the respiratory and the digestive systems, we have been interested in the extraction of the cumin oil. The quality, the yield and the economic obtaining of the essential oil depend not only on the origin and the charactererization of the cumin fruit but also on the process applied for its extraction. In this work we have studied the process of hydrodistillation. We can say that the effect on the yield depend on the extraction duration. This study has allowed us to notice that in the third and fourth hours the effects are of very weak value, which means that prolonging the extraction time does not mean an improvement or amelioration of the yield.

The analysis of the essential oil by gaseous phase chromatography coupled with mass spectroscopy has shown that the Algerian essential oil is mainly composed of cumin-aldehyde or 1-phenyl-1,2-ethanediol as far as quantity is concerned. These components are accompanied by poor quantities of other products like: α-pinene, β-pinene, myrcene, limonène, γ-terpinene, *etc*.

This study has allowed us to optimize the yield of our Algerian essential oil following an extraction time in order to obtain an oil of quality in a shorter period of time (120 min instead of 270 min).

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