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SYNTHESIS OF IONONES FROM CITRAL THROUGH PSEUDOIONONE INTERMEDIATE COMPOUND IN SOUTHERN VIETNAM

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ABSTRACT

Ionones (α, β isomers) was prepared from citral takes place via a strong mineral acid catalyzed two-step process. The first step is the aldol condensation of citral with acetone to give pseudoionone (PS). At the second step, the consecutive cyclization of PS to ionones is catalyzed by strong mineral acid H_3PO_4. Ionones (α, β isomers) was obtained in 56% yield (47% α-ionone and 9% β-ionone, according by GC-MS purity).

KEYWORDS: Ionones, citral, pseudoionone.

1. INTRODUCTION

Ionones (α, β isomers) are widely used in pharmaceutical and perfume industry. β-ionone is used as an agent of the synthesis of β-caroten and vitamin A[1], while α-ionone, an aromafix, is highly appreciated in the perfume industry because of its characteristic rose scent.[2] Ionone has been synthesized and put into use since 1995. Over 25 years of presence in the market, ionone is still used in perfume and pharmaceutical industry. In Viet Nam, the demand for ionone is quite large. Some places produced by themselves but the output is not high, mostly imported from abroad. Therefore, we set out the problem of research and build the synthesis process of this compound in order to be able to produce for domestic demand.

In nature, ionone are found in some flowers and fruits such as raspberries, tomatoes, roses and violets. However, natural resources are often of low content. Exploiting ionone from

distillation of roses, violets will be expensive and have low efficiency. Therefore, current commercial ionone are produced by chemical synthesis.[3] In this study, we performed the process of synthesizing ionone from citral through pseudoionone intermediate with 2 step process. The yield is 56%.

2. EXPERIMENTAL

2.1. Materials and equipment

-Material: Lemongrass essential oil with citral content greater than 60% is provided by the Peroma company, HCM city. Some catalysts and substances such as H_3PO_4, acetone, $NaHSO_3$, NaOH are derived from Merck and Aldrich-Sigma.

-Equipment: magnetic stirring machine, rotary evaporator, some specialized glass equipment, the purity of the product is determined on the GC-MS Agilent Model G5900A.

2.2. Process for preparing of ionones

Process for preparing of ionones from citral through pseudoionone intermediate is done according to Diagram 1.

Preparation of pseudoionone from citral

Step 1: Refined citral from lemongrass essential oil.

Put 10 mL lemongrass essential oil (citral content ≥ 60% GC-MS) into becher 500 mL. Dissolve 100 grams $NaHSO_3$ (0.956 mol) in the amount of water just enough to saturate solution. Then slowly add the saturated $NaHSO_3$ solution to becher 500 mL containing lemongrass essential oil until complete precipitation. Filter through a filter paper to collect the solids. Gradually add 90 mL of NaOH 10% solution to the solids until completely dissolved.

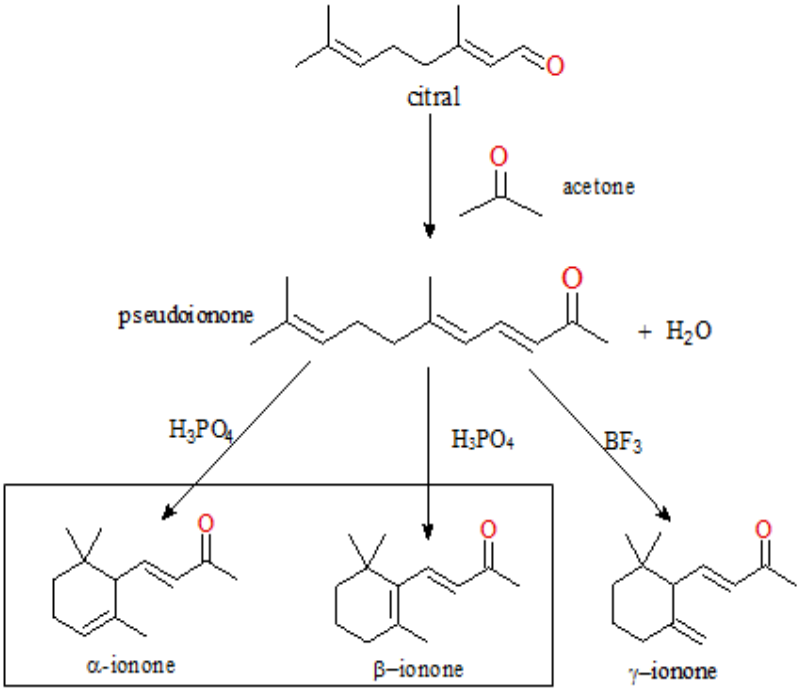

Diagram 1: Process for preparing of ionones from citral through pseudoionone intermediate compound.

Add the resulting solution to the separating funnel, shaking, allow to stand for a while, a yellowish oily liquid emerged from the impurity. Separating layer of liquid oil that is refined citral. The amount of refined citral is 9,0 grams with the citral content ≥ 66% GC-FID.

Step 2: Preparation of pseudoionone from refined citral.

Prepare the catalyst solution of OH^-/ethanol: add 5 mL of ethanol to erlen 50 mL and then add 7,5 mL of NaOH 20% solution. Cool the solution with ice to 20 ^oC (use a thermometer to measure the temperature). Add 2,00 mL (1.79 g, 0.010 mol) citral and 0.75 mL (0.59 g, 0.01 mol) acetone to erlen 125 mL. Let stand for 5 minutes at room temperature. Continuous stirring of the reaction mixture and add slowly the catalyst solution NaOH/ethanol in 30 minutes. Stop stirring and cool the reaction mixture. Check the transformation of citral by thin layer chromatography. Extract the product with diethyl ether 3 times, each time 3 mL. Dry the solution by anhydrous Na_2SO_4.

Filter under lower pressure to remove salt. Distilled the reaction mixture, recover ethanol at 76-78 ^oC, citral (if have) at 228-230 ^oC, and pseudoionone product at 264-266 ^oC. Get 2.5 grams pseudoionone product. The purity of product is 49% GC-MS.

Preparation of ionone from pseudoionone

Add slowly 3.0 mL H_3PO_4 2N to becher 100 mL containing a mixture of 2.5 grams pseudoionone and 8 mL n-hexane. Becher was placed in a pot containing ice so that the reaction temperature remain at 0^oC. The mixture is stirred quickly and strongly for 20 minutes. Add 20 mL ice water and continue stirring for 5-7 minutes.

At the end of the reaction, extract the mixture with n-hexane for 3 times, each time 2.0 mL to remove the aqueous layer. The n-hexane solution obtained after extraction is washed with Na_2CO_3 5% and distilled water until pH=7. Remove water by anhydrous Na_2SO_4. Evaporate to remove n-hexane. Weight and record the weight of the product. The result of GC-MS showed that the purity of the ionone product is 56% *(47% α-ionone and 9% β-ionone).*

3. RESULT AND DISCUSSION

3.1. Determination of citral content in lemongrass essential oil

Lemongrass essential oil was from Peroma company, dictrict 10, HCM city. The certification of analysis (COA) showed that the citral content is quite high (>60%). Preliminary test used thin layer chromatography, eluted with the solvent system of n-hexane:chloroform (5:2), and then illuminated the thin layer under UV lamp at 254 nm.

The result showed a round spot with large area (R_f 0.55) was identified as citral (including 2 isomers Citral A and Citral B). The results of the test showed that the citral content was sufficient to perform the ionone synthesis.

Lemongrass essential oil is then reacted with $NaHSO_3$ to refine citral A and citral B. The obtained product is measured GC-FID, the results showed the presence of 2 peaks with retention time of 36.216 and 38.462 minutes that were identified as citral B and citral A with content of 26.04% and 40.79%, respectively.

3.2 Preparation of pseudoionon from refined citral

Pseudoionone was synthesized through aldol condensation reaction with agents including citral and acetone in base inviroment (diagram 1). Product's purity is determined by GC-MS. The analysis results showed the presence of 2 peak with retention time of 16.110 and 16.870 minutes which were identified as (3*E*,5*Z*)-6,10-dimethylundeca-3,5,9-trien-2-one and (3*E*,5*E*)-6,10-dimethylundeca-3,5,9-trien-2-one ($C_{13}H_{20}O$, M=192) with content of 17.76% and 30.91%, respectively. These are the two isomers of pseudoionone. (Figure 1).

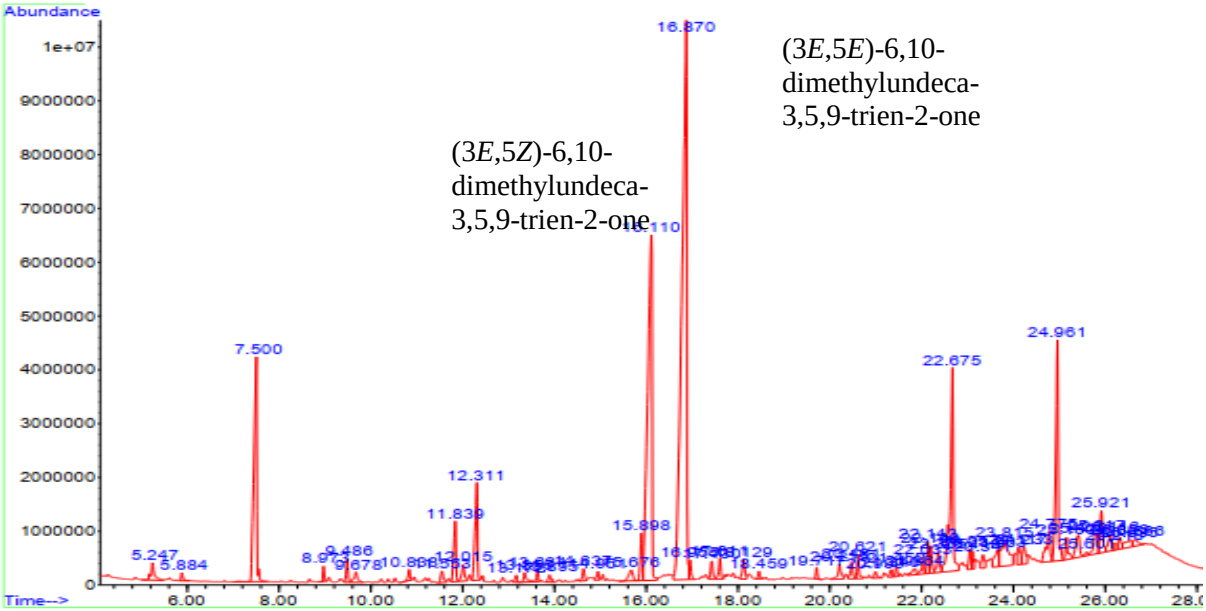

Figure 1: GC-MS analysis of synthesis reaction of pseudoionone.

3.3 Preparation of ionone from pseudoionon intermediate compound

Ionone (α, β isomers) is synthesized through a ring closing reaction by pseudoionone with H_3PO_4 acid catalyst in n-hexane solvent. The purity of products were determined by GC-MS.

The GC-MS analysis results showed the presence of 2 peaks at retention time 14.722, 15.431 which were respectively determined for α-ionone ((*E*)-4-(2,6,6-trimethylcyclohex-2-en-1-yl)-but-3-en-2-one)), β-ionone [4-(2,6,6-trimethylcyclohex-1-ene-1-yl)-but-3-ene-2-one] with product's content are 46.97% and 8.76%. (Figure 2).

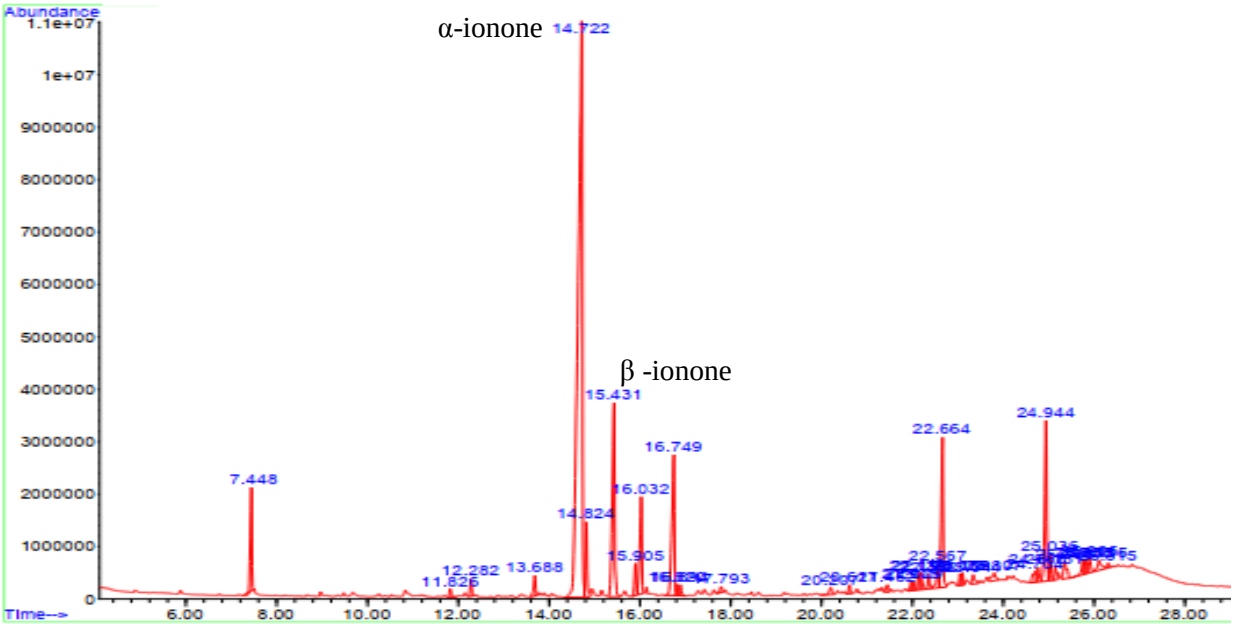

Figure 2: GC-MS analysis of synthesis reaction of ionone.

4. CONCLUSION

Ionone (α, β isomers) is prepared from citral through a 2-step process with an intermediate compound pseudoionone. On the basis of the selected method, the ionone was prepared with an efficiency of 56% yield. This process provided a simple and effective method of producing ionone for the perfume and pharmaceutical industry. This synthesis process is also the basis for futher developments in aromatherapy production research in Viet Nam.

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