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(54) Titre : PROCEDE AMELIORE POUR PRODUIRE DE L'ACIDE VALPROIQUE
(54) Title: IMPROVED PROCESS FOR PRODUCING VALPROIC ACID

(57) Abrégé/Abstract:
An improved process for producing valproic acid from ethyl acetoacetate is disclosed wherein both the dialkylation of ethylacetoacetate with propyl bromide and the conversion of the dialkylester thus obtained to the corresponding salt take place in a single step, in the presence of a phase-transfer catalyst, in a hydroalcoholic environment, and the salt is converted to valproic acid at pH 1-3.

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Abstract

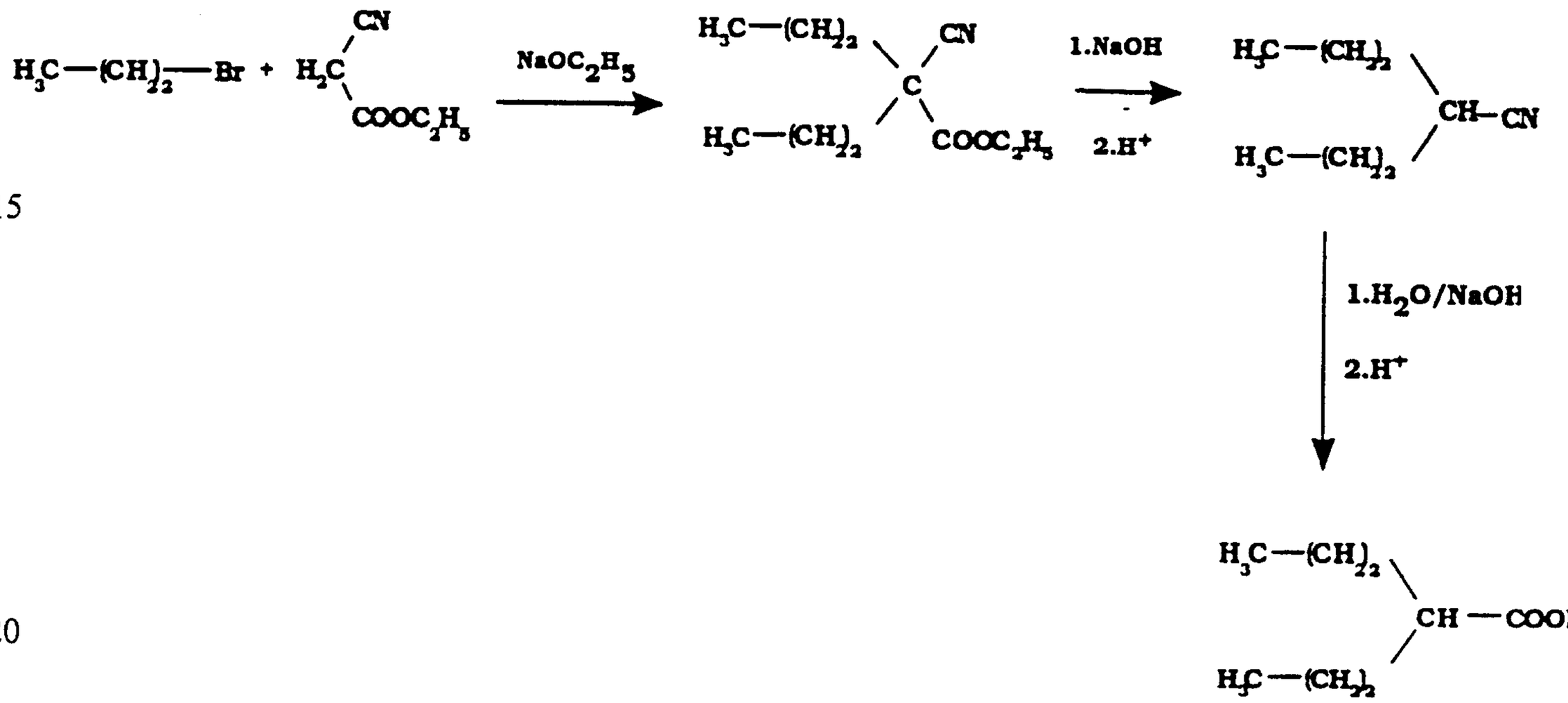
An improved process for producing valproic acid from ethyl acetoacetate is disclosed wherein both the dialkylation of ethylacetoacetate with propyl bromide and the conversion of the dialkylester thus obtained to the corresponding salt take place in a single step, in the presence of a phase-transfer catalyst, in a hydroalcoholic environment, and the salt is converted to valproic acid at pH 1-3.

The present invention relates to an improved process for the preparation of valproic acid.

Valproic acid (2-propylpentanoic acid; di-n-propylacetic acid) and its sodium and magnesium salts have long since been utilized in therapy as anti-epileptic and anti-convulsant drugs.

The conventional process which is still used for the preparation of valproic acid (see Labaz's patents GB 1522450, GB 1529786 and US 4,155,929) substantially comprises dialkylating ethyl cyanacetate with propyl bromide in the presence of sodium ethoxide thus obtaining ethyl α,α–dipropyl cyanacetate which is converted, in a basic enviroment, to dipropyl acetonitrile which by alkaline hydrolysis gives valproic acid.

The reaction scheme of this process is the following:



This conventional process presents serious drawbacks which can be summarized as follows:

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(a) sodium ethoxide entails the use, particularly on the industrial scale, of a substantially anhydrous reaction environment and brings about complex pollution problems;

(b) sodium ethoxide is completely used up during the dialkylation of ethyl cyanacetate;

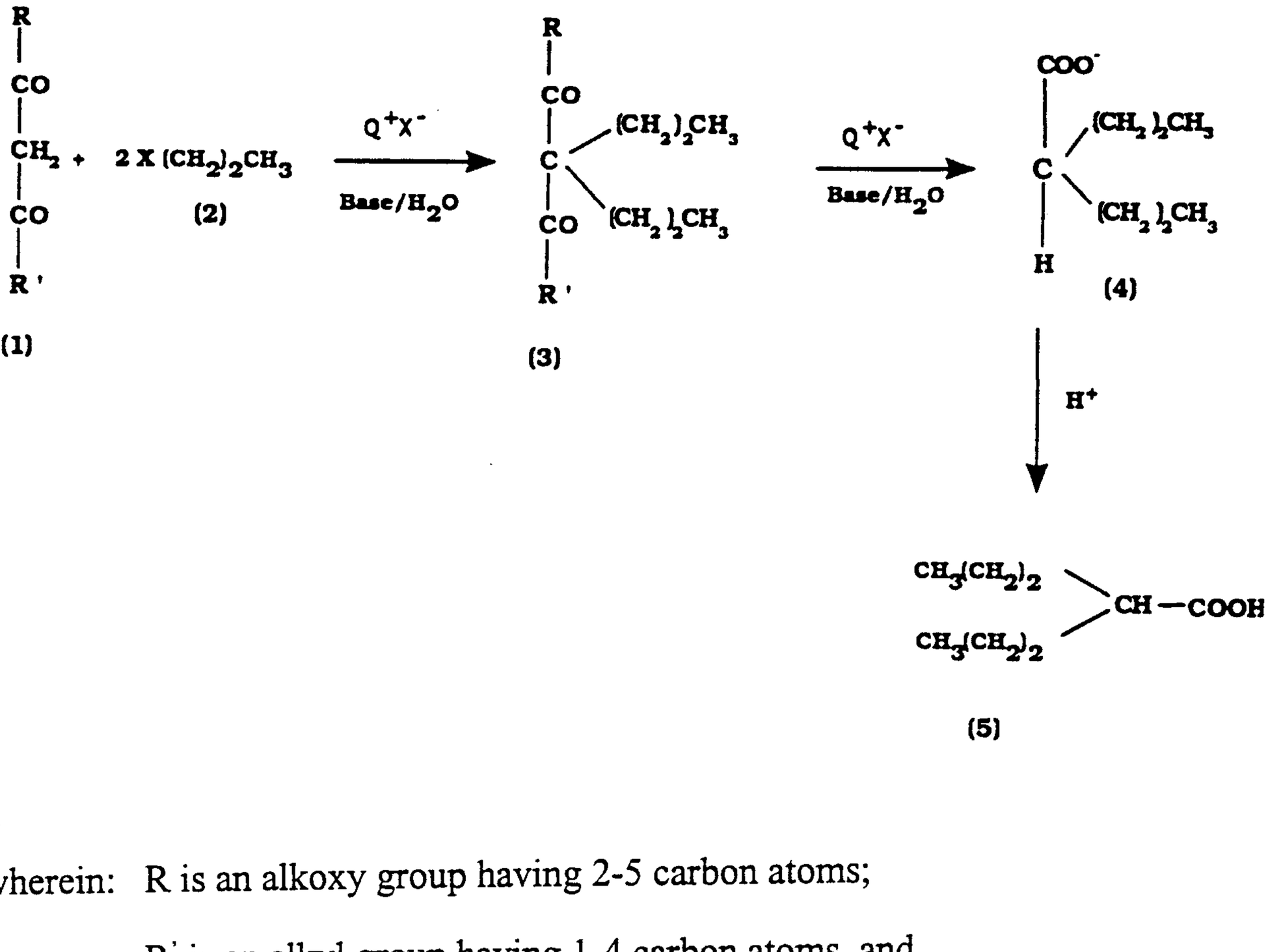
(c) the decarboxylation step of ethyl, α,α-dipropylcyanacetate requires drastic operating conditions, high temperatures and prolonged reaction times;

(d) also the conversion of the nitrile derivative to valproic acid requires drastic hydrolysis conditions, high temperatures (about 200°C) and prolonged reaction times (more than six hours).

As a consequence of the aforesaid disadvantages, it is apparent that the conventional process is remarkably costly because of the nature of the reactants, the energy consumption and the need of utilizing devices and technologies commensurate to the safety and pollution problems inherently brought about by the process itself.

The present invention provides an improved process for producing valproic acid which overcomes or at least mitigates all the foregoing drawbacks. In particular, the present invention provides a process wherein the use of alkaline alkoxides, and particularly of sodium ethoxide, is completely avoided. Further advantages of the improved process according to the invention shall be apparent from the detailed description thereof here below.

The improved process for producing valproic acid according to the present invention is shown in the following reaction scheme:



(1) (3) (4) (5)

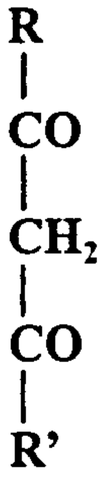
wherein: R is an alkoxy group having 2-5 carbon atoms;

R' is an alkyl group having 1-4 carbon atoms, and

$Q^+ X^-$ indicates a phase-transfer catalyst wherein Q^+ is quaternary ammonium or phosphonium and X^- is any suitable anion, preferably a halogenide anion.

The process comprises the following steps:

(a) dialkylating a beta-ketoester (1) having formula



(1)

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wherein: R is an alkoxy group having 2-5 carbon atoms; and

R' is an alkyl group having 1-4 carbon atoms with a propyl halogenide (2) having formula

$$X(CH_2)_2CH_3$$

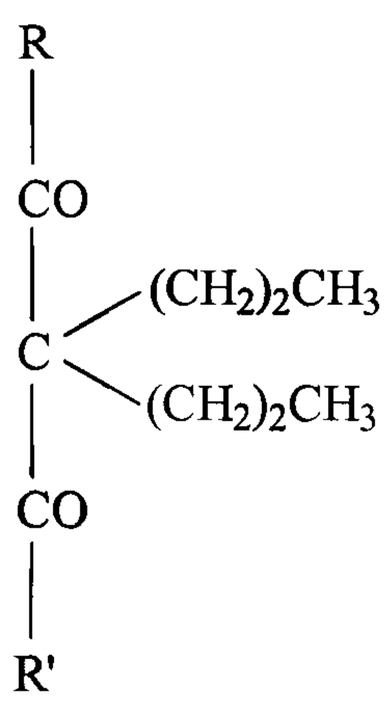
(2)

wherein: X is chlorine, bromine or iodine, preferably bromine

by reacting a biphasic system consisting of

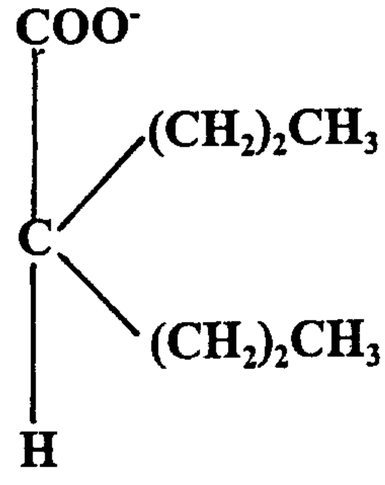
(i) an aqueous phase comprising a base, preferably NaOH, and a phase-transfer catalyst Q^+X^- wherein Q^+ is quaternary ammonium or phosphonium and X^- is any suitable anion, preferably halogenide, and

(ii) an organic phase comprising the beta-ketoester (1) and the propyl halogenide (2), wherein the (2):(1) molar ratio is from 5:1 to 15:1, preferably 10:1, at 60-80°C (inner temp.) for at least 25 hours, thus obtaining, following removal of (2) excess, a biphasic reaction mixture whose organic phase is comprised of the dialkyl-beta-ketoester (3)



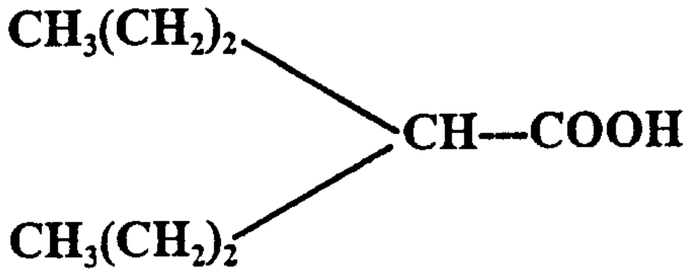
(3)

(b) reacting the mixture obtained in step (a) which comprises the dialkylester (3), in the presence of an alkali, preferably NaOH, at 70-90°C, preferably 80°C, for at least 20 hours, thus obtaining an aqueous phase comprising the salt (4)



(4)

(c) acidifying the aqueous phase comprising the salt (4) of step (b) at pH 1-3, thus obtaining valproic acid (5)



(5)

In the beta-ketoester (1), R is preferably an alkoxy group having 2-3 carbon atoms and R' is an alkyl group having 1-2 carbon atoms. A particularly preferred ester (1) is the ethyl ester of acetoacetic acid.

The propyl halogenide (2) is preferably propyl bromide.

Suitable phase-transfer catalysts Q^+X^- wherein Q^+ is quaternary ammonium or phosphonium and X^- is any suitable anion shall be apparent to the average-skilled expert in organic synthesis. Examples of suitable Q^+X^- catalysts are:

tetrabutylammonium bromide, tetrabutylammonium bisulphate,

benzyltriethylammonium chloride, benzyltributylammonium bromide, tetrabutylphosphonium bromide and benzyltriphenylphosphonium chloride.

A particularly preferred Q^+X^-. Catalyst is tetrabutylammonium bromide (TBABr).

When step (b) is completed, it is economically advantageous to recover the catalyst which can thus be reutilized. Catalyst recovery is achieved by extracting the reaction mixture with an organic solvent, preferably a halogen-containing solvent, such as e.g. dichloethane, chloroform or methylene chloride; concentrating the organic phase thus obtained which is taken up with a precipitating organic solvent, such as e.g. toluene or ethyl acetate, thus obtaining a precipitate consisting of the catalyst which, following filtration, is wholly recovered.

The following non-limiting example shows the preparation of valproic acid via the process of the present invention.

Example: preparation of valproic acid from the ethyl ester of acetoacetic acid.

19.33 (0.06 moles of TBABr were added to a solution of 8 g (0.2 moles) of NaOH in 30 mL H_2O and the resulting mixture was heated at about 80°C till complete dissolution.

After cooling to 60°C, 61.5 (0.5 moles) of propyl bromide and 6.5 g (0.05 moles) of ethyl acetoacetate were contemporaneously added to the mixture. The resulting bi-phasic system was kept under vigorous stirring for 39 hours at 71°C (inner temp.)

30.7 g (0.249 moles) of propyl bromide and a solution of 2.28 g (0.057 moles) of NaOH in 5 mL H_2O were added and the resulting mixture was left to react under the aforesaid conditions for further six hours.

The excess of propyl bromide was distilled off and recovered, thus giving a biphasic reaction mixture whose organic phase consisted of ethyl-2,2-dipropyl

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acetoacetate, which was directly used in the subsequent reaction.

To this mixture comprising the ethyl-2,2-dipropyl acetoacetate a solution of 8 g (0.2 moles) of NaOH in 10 mL H_2O was added ant the resulting mixture left to react at 80°C (inner temp.) for 20 hours.

This end mixture was diluted with water and the catalyst was recovered via CH_2Cl_2 extraction. Following separation from the organic phase, the water phase was acidified at pH 1 wiht 33% HCl and extracted three times with ethyl acetate. It was then dehydrated with anhydrous Na_2SO_4 and concentrated to dryness yielding 3.1 g of valproic acid.

The organic phase was washed three times with water, then the pooled waters were acidified and extracted with ethyl acetate. The organic phase was dehydrated and concentrated to dryness yielding 0.9 g of valproic acid.

The catalyst was recovered by concentrating the organic phase (CH_2Cl_2) and diluting with ethyl acetate thus obtaining the formation of a white precipitate consisting of the catalyst which was filtered off.

G.C. Control: (end product) Rt = 13.78

G.C.: (column: nucol 0.53 mm X 30 m, program temp. 50°C for 3 min. 50°C/min. till 170°C, 20 min. at 170°C, injec temp. 190°C, detector temp. 190°C, carrier gas: helium)

$H^1NMR(CDCl_3)$: δ 0.8 (6H,t,-$CH_2CH_2\underline{CH_3}$); 1.25(4H,m,-$CH_2\underline{CH_2}CH_3$); 1.5(4H,m,-$\underline{CH_2}CH_2CH_3$); 2.25(1H,m,-$\underline{CH}(CH_2CH_2CH_3)_2$); 10.9(1H,s.b.-COO$\underline{H}$)

Gas chromatographic titre against inner standard = 98%.

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Both the novel and unobvious aspects and the remarkable practical and economical advantages afforded by the process of the present invention over the conventional process shall now be apparent to any expert in organic synthesis, particularly to the expert in industrial organic synthesis.

The conversion of the dialkyl-beta-ketoester (3) to the salt (4) (Claisen's inverse reaction) is not carried out according to the conventional method, i.e. in the presence of sodium methoxide or ethoxide and methanol or ethanol, but in the presence of a base (e.g. NaOH) and a phase-transfer catalyst (e.g. TBABr) which, unlike the alkaline alkoxide, is in practice wholly recovered. The remarkable advantages resulting from the elimination of reactants such as the alkaline alkoxides, have been described already.

Claisen's inverse reaction according to the invention lends itself to "fit" with the hydrolysis reaction of compound (3), so that both reactions are in practice carried out in a single step.

It is furthermore apparent that the whole process of the invention can be conducted as a continous sequence of operations, i.e. without isolating the reaction intermediates, but rather simply by adjusting the various operational conditions to the values suited for the specific step being carried out.

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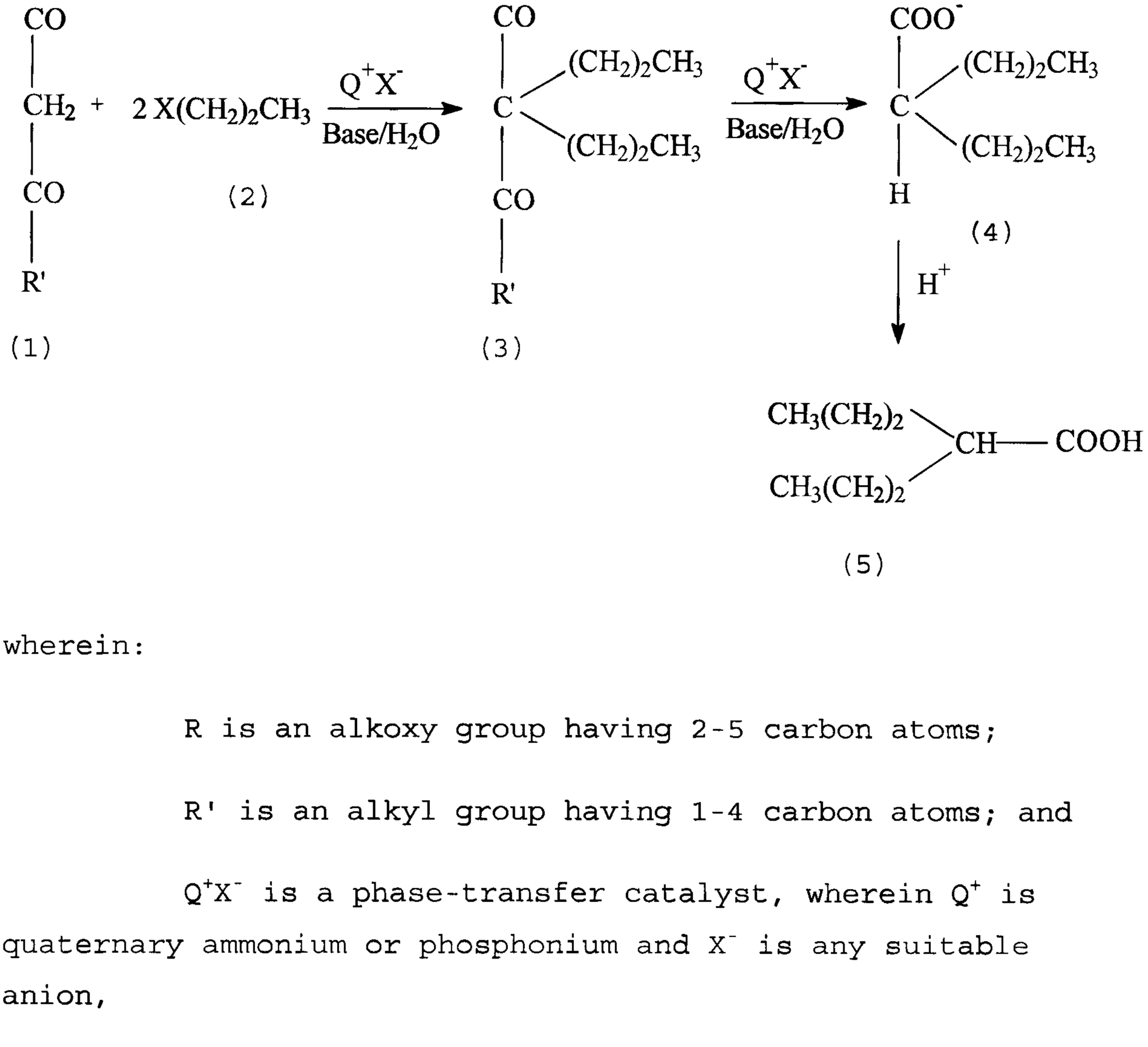
CLAIMS:

1. A process for producing valproic acid according to the following reaction scheme:



(5)

wherein:

R is an alkoxy group having 2-5 carbon atoms;

R' is an alkyl group having 1-4 carbon atoms; and

Q^+X^- is a phase-transfer catalyst, wherein Q^+ is quaternary ammonium or phosphonium and X^- is any suitable anion,

which comprises the following steps:

(a) dialkylating the beta-ketoester (1) as defined in the reaction scheme with a propyl halogenide (2) having general formula:

$$X(CH_2)_2CH_3$$

(2)

wherein X is Cl, Br or I,

by reacting a biphasic system consisting of:

(i) an aqueous phase comprising a base and the phase-transfer catalyst Q^+X^-, wherein Q^+ and X^- are as defined above; and

(ii) an organic phase comprising the beta-ketoester (1) and the propyl halogenide (2), wherein the (2):(1) molar ratio is from 5:1 to 15:1 at 60-80°C, inner temperature, for at least 25 hours, thus obtaining, following removal of excess (2), a biphasic reaction mixture wherein the organic phase is comprised of the dialkyl-beta-ketoester (3) as defined in the reaction scheme;

(b) reacting the mixture obtained in step (a) which comprises (3), in the presence of an alkali at 70-90°C for at least 20 hours, thus obtianing an aqueous phase comprising the salt (4) as defined in the reaction scheme; and

(c) acidifying the aqueous phase comprising the salt (4) of step (b) at pH 1-3, thus obtaining valproic acid.

2. The process of claim 1, wherein:

X^- is a halogenide anion;

X is Br;

the base in (i) is NaOH;

the (2):(1) ratio in (ii) is 10:1; and

the alkali in step (b) is NaOH, and the temperature is 80°C.

3. The process of claim 1 or 2, wherein (1), R is an alkoxy group having 2-3 carbon atoms and R' is an alkyl group having 1-2 carbon atoms.

4. The process of claim 3, wherein (1) is the ethyl ester of acetoacetic acid.

5. The process of any one of claims 1 to 4, wherein (2) is propyl bromide.

6. The process of any one of claims 1 to 5, wherein the phase-transfer catalyst Q^+X^- is selected from the group consisting of tetrabutylammonium bromide, tetrabutylammonium bisulphate, benzyltriethylammonium chloride, benzyltributylammonium bromide, tetrabutylphosphonium bromide and benzyltriphenylphosphonium chloride.

7. The process of claim 6, wherein Q^+X^- is tetrabutylammonium bromide.

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