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**IMPROVED PROCESS FOR THE MANUFACTURE OF CYCLOALKYL AND
HALOALKYL o-AMINOPHENYL KETONES**

Cycloalkyl and haloalkyl o-aminophenyl ketones are utilized as starting materials in the manufacture of herbicidal sulfamoyl urea derivatives. The regiospecific preparation of o-aminophenyl ketone derivatives is described in U.S. 4,160,784. Said patent provides a broad inclusive method to prepare a wide variety of aromatic and nonaromatic, substituted and unsubstituted o-aminophenyl ketones. However, in many instances the formation of unwanted side-products can cause decreased yields and cumbersome product isolation procedures.

The compound o-aminophenyl cyclopropyl ketone is particularly useful in the manufacture of 1-(o-cyclopropylcarbonyl)phenylsulfamoyl urea derivatives which are highly potent, yet environmentally benign, cereal crop tolerant herbicides. Methods known to prepare o-aminophenyl cyclopropyl ketone such as those described in U. S. Patents 4,160,784 and 5,009,699 use cyclopropyl nitrile as starting material. However, cyclopropyl nitrile is not commercially nor readily obtainable, whereas 4-chlorobutyronitrile is obtainable commercially. However, there is no effective method available to prepare o-



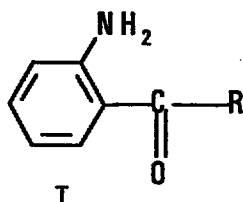
aminophenyl cyclopropyl ketone from its 4-halo acyclic precursor, 1-(o-aminophenyl)-4-halo-1-butanone.

Therefore, it is an object of this invention to provide an improved process for the preparation of cycloalkyl and haloalkyl o-aminophenyl ketones which gives significantly reduced side-product formation and increased product yield.

It is a further object of this invention to provide an effective process for the preparation of o-aminophenyl cyclopropyl ketone via the dehydrohalogenation of 1-(o-aminophenyl)-4-halo-1-butanone.

It is a further object of this invention to provide an economic and convenient source of starting materials for the manufacture of herbicidal sulfamoyl urea derivatives.

The present invention provides an improved process for the manufacture of an o-aminophenyl ketone of formula I



wherein R is C₃-C₆cycloalkyl or C₁-C₆haloalkyl, which comprises the following steps:

- (1) reacting a nitrile of formula II

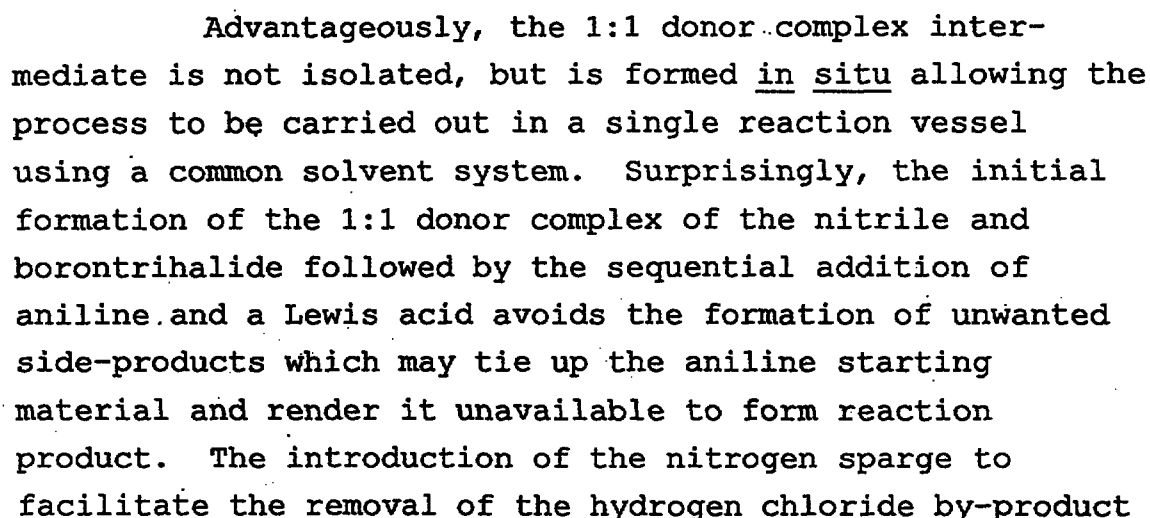


II

with borontrihalide in the presence of a solvent to form a 1:1 donor complex,

- (2) reacting the complex with aniline in the presence of a Lewis acid to give a reaction mixture,

FLOW DIAGRAM I



further enhances product yield and purity by decreasing, or eliminating, acid-catalyzed side reactions. It has now been found, that on a commercial scale an external force is critical to the effective removal of the hydrogen chloride gas by-product so that side reactions and reactant degradation are avoided.

Solvents suitable for use in the process of the invention are organic solvents such as halogenated hydrocarbons, for instance methylene chloride, dichloroethane, dichloropropane and the like; aromatic hydrocarbons such as toluene, xylene, benzene and the like; halogenated aromatics such as chlorobenzene, dichlorobenzene and the like. Preferred solvents are dichloroethane, dichloropropane and toluene and the more preferred solvent is dichloroethane.

The preferred Lewis acid for use in the inventive process is aluminum chloride.

The nitrogen sparge accelerates the loss of hydrogen chloride gas and helps to drive the reaction to completion. This acceleration, and the use of an inert gas such as nitrogen, appears to be critical to enhanced product yield and quality. Reaction time during the nitrogen sparge may range from about 1-24 hours, preferably about 8-16 hours and more preferably about 12 hours.

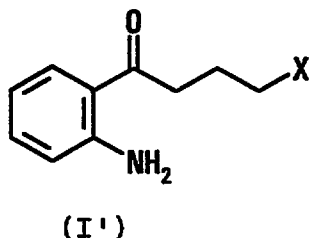
Reaction rate increases with increased temperatures, however increased temperatures also increase reactant degradation and other undesirable side-reactions. Elevated temperatures suitable for the nitrogen sparge time period are about 30° to 150°C, preferably about 80° to 110°C.

Although stoichiometric proportions of reactants are suitable, a preferred range for the proportion of a nitrile of formula II to one molar equivalent of aniline is about 1 to 2 moles and more preferred is about 1.3 to 1.5 moles.

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The present invention further provides a process for the preparation of o-aminophenyl cyclopropyl ketone which comprises reacting a compound of formula I'



wherein X is chlorine or bromine with at least one molar equivalent of an aqueous base in the presence of a phase transfer catalyst and optionally in the presence of an organic solvent.

O-aminophenyl cyclopropyl ketone may be effectively prepared with minimal side-product formation by the dehydrohalogenation of 1-(o-aminophenyl)-4-halo-1-butanone using at least one molar equivalent, preferably 1.1 - 3.0 molar equivalents, of an aqueous base in the presence of a phase transfer catalyst and optionally in the presence of an organic solvent.

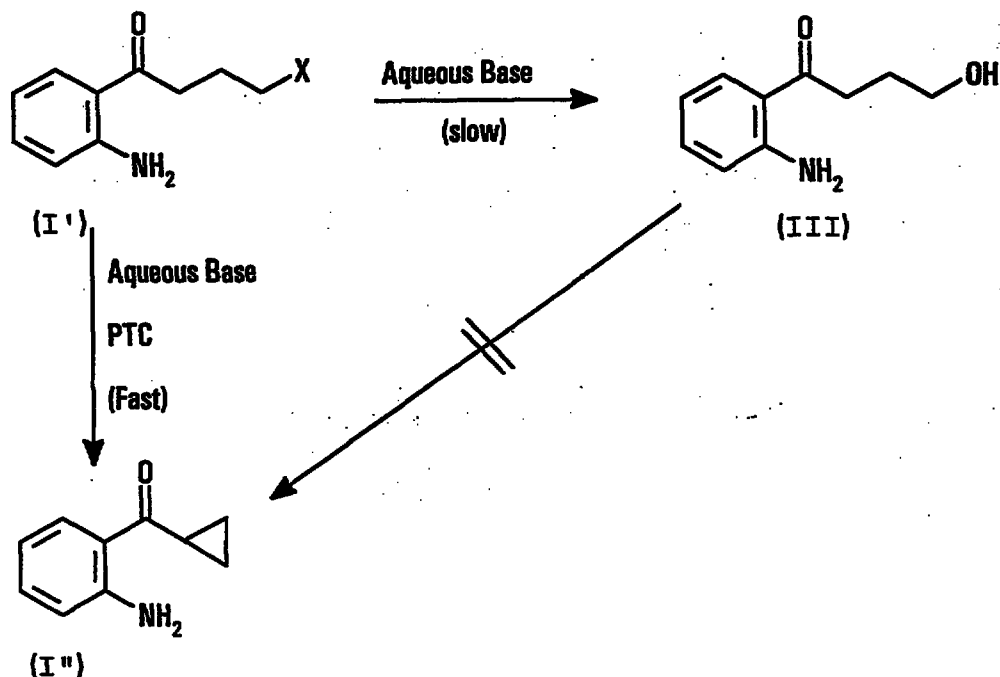
Although the dehydrohalogenation of a γ -haloalkyl ketone using aqueous base is known to form the corresponding cycloalkyl ketone, for example, as described in Organic Synthesis, Coll. Vol. 4, pp. 597-600 (1963), when these procedures are applied to 4-halobutanone compounds of formula I wherein X is chlorine or bromine, the reaction proceeds slowly and the major product is mainly the 4-hydroxy analogue of formula III.

Surprisingly, it has been found that when a phase transfer catalyst (PTC) is present in the reaction mixture, the reaction rate is effectively increased and the major product is the desired cyclopropyl ketone of formula I". The reaction scheme is shown in flow diagram II.

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Flow Diagram II



Phase transfer catalysts suitable for use in the inventive process are those well known in the art such as, quaternary ammonium salts, for example tri-alkyl ammonium salts or tetralkylammonium salts, preferably tri- or tetrabutylammonium halides. An effective amount of the catalyst may range from about 0.001 - 0.50 molar equivalents.

Aqueous bases suitable for the preparation of *o*-aminophenyl cyclopropyl ketone by the present process include sodium and potassium hydroxide, carbonate or bicarbonate or mixtures thereof at concentrations in aqueous solution of about 15% to 50% by weight in amounts sufficient to provide at least one molar equivalent, preferably about 1.1 to 3.0 molar equivalents, and more preferably about 1.5 to 2.5 molar equivalents.

The organic solvent may be any inert water immiscible solvent or mixtures of solvents such as halogenated hydrocarbons, alkyl and aromatic ethers, aromatic hydrocarbons, halogenated aromatic



hydrocarbons, and the like, preferably halogenated hydrocarbons such as methylene dichloride, ethylene dichloride, propylene dichloride and the like.

In accordance with the process of the invention, a 4-halobutanone compound of formula I', optionally dissolved in an organic solvent or mixture of solvents, is admixed with at least one molar equivalent of an aqueous base, preferably about 1.1 - 3.0 molar equivalents, more preferably about 1.5 - 2.5 molar equivalents and a quaternary ammonium phase transfer catalyst, preferably methyl tributylammonium chloride, in an amount of about 0.001 - 0.50 molar equivalents, preferably about 0.025 - 0.50 molar equivalents.

For a more clear understanding of the invention, specific examples thereof are set forth below. These examples are merely illustrative and are not to be understood as limiting the scope and underlying principles of the invention in any way.

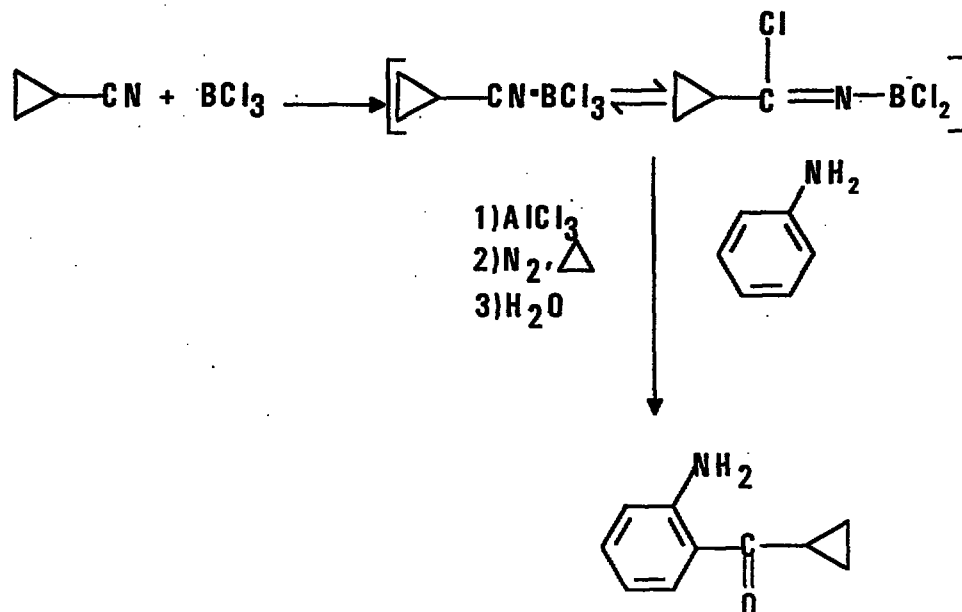
The terms HPLC and GC designates high performance liquid chromatography and gas chromatography, respectively.

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EXAMPLE 1

PREPARATION OF o-AMINOPHENYL CYCLOPROPYL KETONE

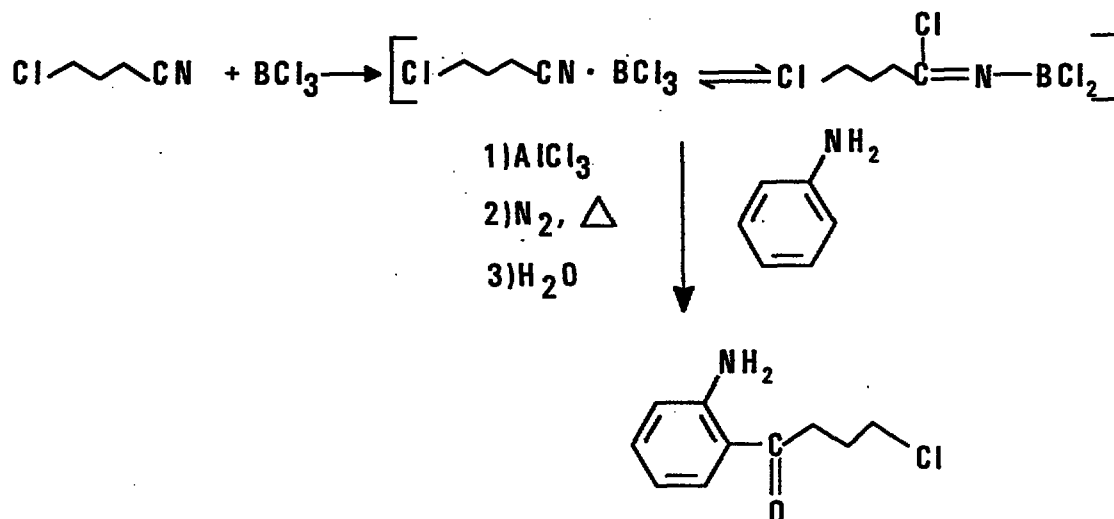


A stirred mixture of BCl_3 (145.2g, 1.238 mole) in dichloroethane is treated with cyclopropyl nitrile (101.8g, 1.45 mole) over a 45 minute period at -3° to 5°C , stirred for 1 hour at 5° to 10°C , treated with aniline (112.2g, 1.205 mole) over a 1 hour period at 7° to 12°C , stirred for 1 hour, treated with AlCl_3 (170.7g, 1.281 mole) in a single portion and stirred at ambient temperatures for 1 hour. The reaction mixture is sparged with nitrogen and heated at reflux temperatures with a nitrogen sparge for 17-18 hours. The heated and sparged reaction mixture is cooled to 15°C , added to approximately a 2-fold volume of water (based upon initial reaction mixture volume) over a 30 minute period at 9° to 38°C and stirred at 35° to 38° for 1 hour. The phases are separated and the aqueous phase is extracted with methylene chloride. The organic phases are combined and

concentrated in vacuo to give the title product as an orange oil which crystallizes on standing, 149.8g, 95.6% pure, 73.7% yield, identified by HPLC analysis.

EXAMPLE 2

PREPARATION OF 1-(o-AMINOPHENYL)-4-CHLORO-1-BUTANONE

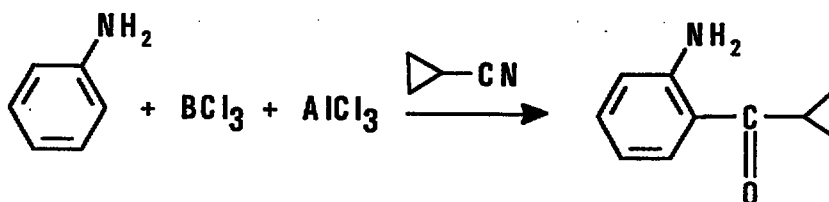


A mixture of BCl_3 (59.2g, 0.50 mole) in 1,2-dichloroethane is treated with 4-chlorobutyronitrile (62.5g, 0.604 mole) over a 1 hour period at -8° to 0°C , stirred for 1 hour at 0° to 5°C , treated with aniline (45.1g, 0.485 mole) over a 1 hour period at 2° to 9°C , stirred for 1 hour, and treated with AlCl_3 (68.8g, 0.515 mole) in a single portion at ambient temperatures. The reaction mixture is sparged with nitrogen at reflux temperature for about 17 hours. The heated and sparged reaction mixture is cooled to 35°C and added to approximately a 2-fold volume of water (based upon initial reaction volume) and stirred for 0.5 hour at 33° to 35°C . The phases are separated and the aqueous phase is washed with 1,2-dichloroethane. The organic phases are combined

and concentrated in vacuo to give a solution of the title product containing, 85.9g of the desired o-aminophenyl ketone, 89.7% yield, identified by HPLC analysis.

EXAMPLE 3

COMPARATIVE PREPARATION OF 1-(o-AMINOPHENYL) CYCLOPROPYL KETONE

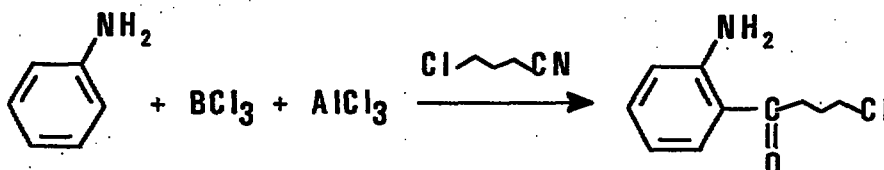


The procedure used in this example is essentially the same as that described in U. S. Patent 4,160,784.

A solution of aniline (2.7g, 0.029 mole) in 1,2-dichloroethane is treated with BCl_3 (3.40g, 0.029 mole) over a 20 minute period at -8° to 5°C , stirred at -2° to 5°C for 35 minutes, treated with cyclopropyl nitrile (2.9g, 0.043 mole) over a 15 minute period at 0° to 5°C , treated with AlCl_3 (4.2g, 0.0315 mole) in a single portion and stirred at ambient temperatures for 1.5 hours. The reaction mixture is heated at reflux temperature for 18 hours, added to an excess volume of water and stirred for 16 hours. The phases are separated and the aqueous phase is extracted with methylene chloride. The organic phases are combined and concentrated in vacuo to give the title product, 2.55g, 90% pure, 49.1% yield, identified by HPLC analysis.

EXAMPLE 4

COMPARATIVE PREPARATION OF 1-(o-AMINOPHENYL)-4-CHLORO-1-BUTANONE

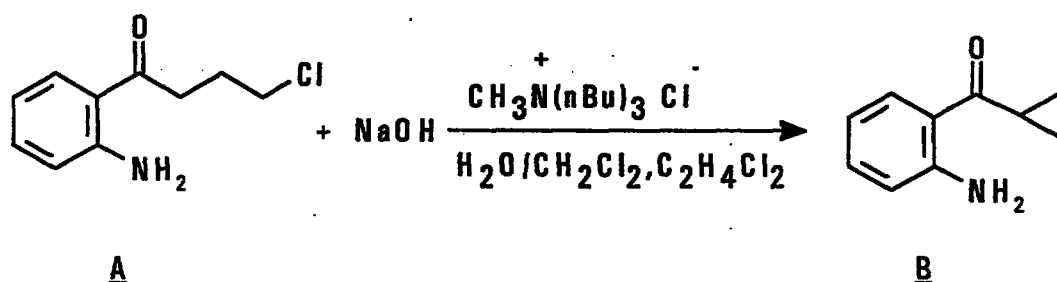


The following procedure is described in U. S. Patent 4,988,695.

To a solution of boron trichloride (55 g) in 1,2-dichloroethane (200 ml) at 0° was added dropwise a solution of aniline (39.1 g, 0.42 mol) in 1,2-dichloroethane (50 ml) maintaining the temperature below 5° . On completion of the addition 4-chlorobutyronitrile (41.4 g, 0.42 mol) and aluminium chloride (53.34 g, 0.42 mol) were added successively and the reaction mixture allowed to warm up to room temperature then heated under reflux for 20 hours. After allowing to cool, 2N hydrochloric acid (100 ml) was added and the reaction mixture heated under reflux for 0.5 hour. The solid obtained was collected by filtration, taken up in water and extracted with chloroform (5 X 200 ml). The chloroform extracts were combined, washed with dilute base, then water, dried over magnesium sulphate, filtered and evaporated under reduced pressure to give an oil. The oil was dissolved in ether and ethanolic HCl was added, the resulting solid was collected by filtration and dried, 28.5 g, 29% yield. Recrystallization from ethanol/diethylether gave the product hydrochloride salt, m.p. 152° - 154°C .

EXAMPLE 5

Preparation of o-aminophenyl cyclopropyl ketone via the dehydrohalogenation of 1-(o-aminophenyl)-4-chloro-1-butanone in the presence of a phase transfer catalyst



A solution of 1-(o-aminophenyl)-4-chloro-1-butanone (32.6g, 0.165 mole) in ethylenedichloride is treated with 147.3g of 20% aqueous NaOH (0.736 mole NaOH) and 2.31g of 75% aqueous methyl tributylammonium chloride (0.0074 mole), and stirred at 50°- 53°C for about 4 hours. (Samples are removed at intervals and analyzed by HPLC.) The reaction is cooled to room temperature and the phases are separated. The organic phase is washed with water and concentrated in vacuo to give the title product, 29.84g, 70.6% pure, 79.2% yield by HPLC and GC analyses.

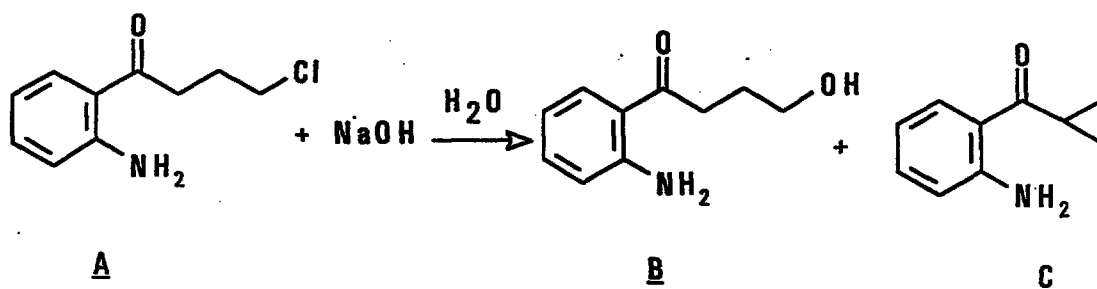
Reaction progress is shown in Table I.

Table I

<u>Sample</u>	<u>Time</u> <u>h</u>	<u>% A</u>	<u>% B</u>
1	0.0	100.0	0.0
2	0.5	28.4	66.9
3	1.0	12.2	80.6
4	3.0	0.5	94.6
5	4.0	0.0	96.3

EXAMPLE 6

Evaluation of the effect of a phase transfer catalyst on the dehydrohalogenation of 1-(o-aminophenyl)-4-chloro-1-butanone



GENERAL PROCEDURE

A mixture of 1-(o-aminophenyl)-4-chloro-1-butanone (35.6g, 0.18 mole) in a solvent mixture of ethylene dichloride and methylene dichloride and 146g of 20% aqueous NaOH (0.73 mole) is stirred at 50°- 85°C for 9 hours. After the 9 hour period, methyl tributylammonium chloride (1.74g, 0.0074 mole) is added and stirring is continued for an additional 0.5 hour. Aliquots of the reaction mixture are removed at 0.5 - 1 hour(h) time intervals and are assayed for the presence of starting material (A), 1-(o-aminophenyl)-4-hydroxy-1-butanone (B) and o-aminophenyl cyclopropyl ketone (C). The results are recorded and shown in Table II below. The assays are performed using HPLC analysis.

Table II

<u>Sample</u>	<u>Time</u> <u>h</u>	<u>Temp.</u> <u>°C</u>	<u>%A</u>	<u>%B</u>	<u>%C</u>
1	0	50	92.0	1.0	0.0
2	0.5	50	85.6	0.9	0.5
3	1.0	50	89.0	1.5	1.8
4	2.0	50	89.4	2.2	0.8
5	3.0	50	91.2	3.8	1.1
6	4.0	50	83.0	3.8	1.0
7	5.0	67	86.4	6.9	1.5
8	6.0	67	83.0	7.8	1.7
9	7.0	67	78.0	14.1	3.2
10	8.0	76	73.0	19.2	3.5
11	9.0	85	51.8	33.5	7.1
12	9.5	85	0.0	34.3	56.0

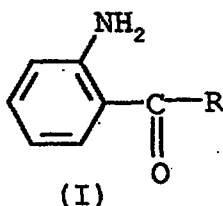
As can be seen from Table II above, in the absence of a phase transfer catalyst (samples 1-11) the starting 4-chlorobutanone (A) is preferentially and slowly converted to the unwanted 4-hydroxybutanone by-product (B). However, 0.5 hour after the addition of the phase transfer catalyst (sample 12), the starting material is completely converted to, preferentially, the desired cyclopropyl ketone product (C). Hence, the reaction rate to the desired product (C) is about 250 times greater in the presence of a phase transfer catalyst than in the absence of a phase transfer catalyst.



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I CLAIM:

1. A process for the manufacture of an o-aminophenyl ketone of formula I



wherein R is C₃-C₆cycloalkyl or C₁-C₆haloalkyl which comprises the following steps:

- (1) reacting a nitrile of formula II



with borontrihalide in the presence of a solvent to form a 1:1 donor complex,

- (2) reacting the complex with aniline in the presence of a Lewis acid to give a reaction mixture,
- (3) sparging the reaction mixture with an inert gas at an elevated temperature for a period of about 1-24 hours and
- (4) quenching the sparged reaction mixture with water to give the formula I product.

2. The process according to claim 1 wherein the solvent is dichloropropane or dichloroethane, the borontrihalide is borontrichloride, the Lewis acid is aluminum chloride, the inert gas is nitrogen, the elevated



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temperature is about 30°C to 110°C and the sparging period is about 8 to 16 hours.

3. The process according to claim 2 wherein the solvent is dichloroethane and the sparging period is about 12 hours.

4. The process according to claim 2 wherein the molar ratio of formula II compound to aniline is about 1:1 to about 2:1.

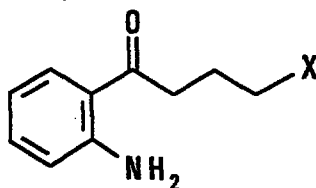
5. The process according to claim 4 wherein the molar ratio of formula II compound to aniline is about 1.3:1 to 1.5:1.

6. The process according to claim 1 wherein the nitrile of formula II is cyclopropyl nitrile.

7. The process according to claim 1 wherein the nitrile of formula II is 4-halobutyronitrile.

8. The process according to claim 7 wherein the 4-halobutyronitrile is 4-bromobutyronitrile or 4-chlorobutyronitrile or mixtures thereof.

9. A process for the preparation of o-amino-phenyl cyclopropyl ketone which comprises reacting a compound of formula I'



(I')

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wherein X is chlorine or bromine with at least one molar equivalent of an aqueous base in the presence of a phase transfer catalyst and optionally in the presence of an organic solvent.

10. The process according to claim 9 wherein the organic solvent is present and is ethylenedichloride, methylenedichloride, propylenedichloride or mixtures thereof, the aqueous base is NaOH or KOH and the phase transfer catalyst is a trialkylammonium halide or a tetraalkylammonium halide.

11. The process according to claim 10 wherein X is chlorine.

12. The process according to claim 10 wherein the aqueous base is present in an amount of about 1.5 to 2.5 molar equivalents.

13. The process according to claim 10 wherein the phase transfer catalyst is methyl tetrabutylammonium chloride and the aqueous base is NaOH.

14. A process for the preparation of o-aminophenyl cyclopropyl ketone which comprises the following steps:

- (1) reacting a 4-halobutyronitrile with a borontrihalide in the presence of a solvent to form a 1:1 donor complex,
- (2) reacting the complex with aniline in the presence of a Lewis acid to give a reaction mixture,
- (3) sparging the reaction mixture with an inert gas at an elevated temperature for a period of about 1-24 hours,

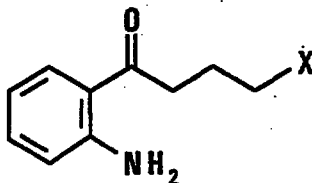
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- (4) quenching the sparged reaction mixture with water to give a compound of formula I'



(I')

wherein X is chlorine or bromine,
and further reacting the formula I' compound with at least one molar equivalent of an aqueous base in the presence of a phase transfer catalyst and optionally in the presence of an organic solvent.

15. The process according to claim 14 wherein the solvent is dichloroethane or dichloropropane, the 4-halobutyronitrile is 4-bromobutyronitrile or 4-chlorobutyronitrile or mixtures thereof, the molar ratio of the 4-halobutyronitrile to aniline is about 1:1 to about 2:1, the borontrihalide is borontrichloride, the Lewis acid is aluminum chloride, the inert gas is nitrogen, the elevated temperature is about 30°C to 110°C and the sparging period is about 8 to 16 hours.

16. The process according to claim 15 wherein the organic solvent is present and is ethylenedichloride, methylenedichloride, propylenedichloride or mixtures thereof, the aqueous base is NaOH or KOH and the phase transfer catalyst is methyl tetrabutylammonium chloride.

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