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FURTHER IMPROVEMENTS IN ISOMERIZATION OF OLEFINS IN SOLVENT-FREE CONDITIONS

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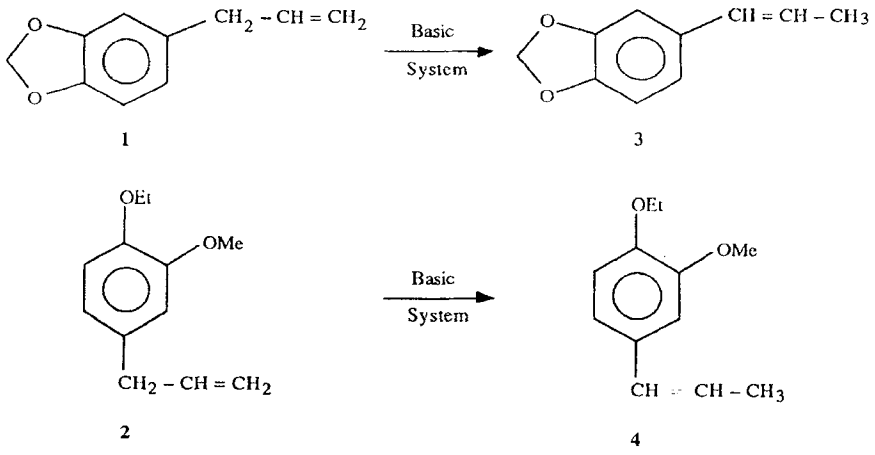
Abstract

Isomerization of safrole and ethyleugenol are performed quasi-quantitatively within 5 minutes at 80°C using KOH or KOtBu and catalytic amount of transfer agent in the absence of solvent. Transfer agent can be avoided in the case of KOtBu with eventually increase in reaction time. Isolated yields of 99 % are obtained from 10 g of materials.

Isomerization of olefins is a synthetically useful reaction. Syntheses of such well known compounds as isoeugenol or isosafrole[1] involve isomerization of allylic substrates. This transformation is generally brought about by base-catalysed rearrangement[2]. Recently, potassium fluoride impregnated on alumina has been shown to bring about the hydrogen bond assisted reactions with great facility[3]. So, it was shown that olefins undergo smooth isomerization to the thermodynamically more stable form on treatment with KF-Alumina in dry ethylene glycol[4]. Yields with safrole **1** and ethyl eugenol **2** were respectively 76 and 75 % after 15-20 mn at 150°C.



This paper describes the optimization in the yields and experimental conditions for these two isomerizations. To this purpose, we have examined various conditions in the case of safrole → isosafrole isomerization :

a) the classical KOH-EtOH system as a model for base catalysed reactions in presence of solvent.

b) the potassium fluoride/alumina reagent either in presence of an organic solvent[5] (EG = ethyleneglycol) or in its absence i.e in "dry media" conditions[6] which lead very often to large enhancements in kinetics when compared to the first case[7].

c) the use of KOH in presence of CaO, recommended by a Japanese patent[8], in the absence of solvent at high temperature.

d) the phase transfer catalysis (PTC) in the absence of solvent, i.e. the use of KOH or KOtBu as bases and catalytic amounts of tetraalkyl ammonium salts as catalysts, method which was shown as very efficient when anionic activation is concerned[9].

Results are presented in Table I.

It appears clearly that :

– Dry media conditions for KF-Al_2O_3 lead to better results with regard to the same reagent in the presence of solvent as yields are significantly improved (91 % versus 76 %) ;

Table I

Isomerization of safrole **1** → **3**[b)]

Basic System	Reaction Conditions		Yield (gc)
	time (min)	temperature °C	% 3
KOH-EtOH	600	78	97
KF-Alumina + EG[4]	20	150	76
KF-Alumina "dry media"	30	150	91
KOH-CaO (1:15)	20	245	97
KOH-Aliquat (5 %)	5	80	96
KOtBu	180	80	96
KOtBu-Aliquat (5 %)	5	80	99[a)]

a) Isolated yield = 99 % starting from 10 g of safrole

b) **3** is constituted by a E/Z mixture ≃ 95/5.

– The best results are obtained with 1.2 mol. eq. KOH or KOtBu in the presence of Aliquat 336[10] without added organic solvent : yields are nearly quantitative within 5 minutes at 80°C. It is obvious to point out that Aliquat is not an absolute necessity as in its absence yield is 96 % within 3 hours.

These results (excellent yields in exceptionnally mild conditions) constitute a serious amelioration compared to the previous ones.

These methodologies were enlarged to the isomerization of ethyl eugenol **2** into iso ethyleugenol **4** (Table II).

As above, dry media conditions are better for KF-Al_2O_3 reagent as yields are significantly improved from 75 to 97 %. *The most efficient system is the use of 1.2 mol. eq of neat KOtBu without solvent* i.e. the simpler conditions the better yield (98 % within 5 minutes at 80°C).

Finally, first attempts to generalization to eugenol → isoeugenol were tested.

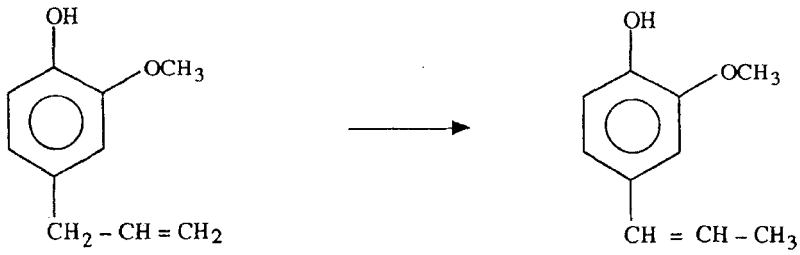
Table II

Isomerization of ethyl eugenol 2 → 4[b)]

Basic System	Reaction Conditions		Yield (gc)
	time (min)	temperature °C	% 4
KF-Alumina + EG[4]	15	150	75
KF-Alumina "dry media"	15	150	97
KOH	10	80	34
KOH-Aliquat (5 %)	5	80	94
KOtBu	5	80	98[a)]

a) Isolated yield = 98 % starting from 10 g of ethyl eugenol

b) Ethyl Isoeugenol Z and E E/Z ≈ 90/10.



The best previous results are 60 % using KOH-Aliquat within 90 minutes at 200°C. It needs therefore further ameliorations and modifications (either in additives or in technology) in this specific case. Consequently, new work is in progress.

Experimental

a) KOH-EtOH system

KOH (3g), EtOH (5g) are heated reflux until homogene. Then added, in one portion, 3g safrole, refluxed further each one case, 8, 10, 12, 14 hrs. After the isolation, the products contained 92, 97, 98, 97 % isosafrole.

b) KF/Alumina system

To KF-Al_2O_3 reagent (10g) previously prepared[4], safrole or ethyleugenol (1g) possibly in dry ethylene glycol is added in one lot. The mixture is stirred and heated at 150°C. After the indicated times, the reaction mixture is cooled, diluted with 50 ml water and acidified with 10 % HCl solution. Toluene is added, separated and concentrated to get the isomerized olefin.

c) KOH-CaO system

Safrole (100 g), CaO (15 g) and KOH (1g) are heated in 15, 20, 25 mn et 242-245°C. The CaO and KOH filtered off and the filtrate contained 94, 96, 95 % isosafrole.

d) PTC conditions without solvent

To 10 mmoles safrole or ethyleugenol are added 12 mmoles of solid crushed base (KOH or KOtBu) and possibly 5 % mol. eq. Aliquat 336. After shaking vigorously, the mixture is left at 80°C within 5 minutes. After cooling to room temperature, organic products are diluted with 50 ml CH_2Cl_2 and filtered over 5 g Florisil. Methylene chloride is removed under reduced pressure to obtain pure isomerized olefins.

In all cases, organic products **1-4** were analyzed by GC with an internal standard (capillary column OV1 25 m, temperature range - 120-200°C) and characterized by ^1H NMR and comparison with authentic samples.

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