Optimization of Reaction Parameters for Natural Aroma Esters Synthesis by Factorial Design

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Chromatographic analysis of the esterification products

The oven programs, retention times and relative response factors (RRF) for the investigated compounds can be found in **Table S1**. Chromatographic separation of the starting alcohols and the corresponding esters can be found in **Figure S1-S7**.

Table S1. Chromatographic separation conditions for the esters of interest and the corresponding relative response factors at 160°C.

Compound name	*Retention time [min]*	*Relative response factor*
Anisyl propionate	8.7	1.2288
Anisyl butyrate	11.8	1.4951
Cinnamyl propionate	10.1	0.6128
Cinnamyl butyrate	14.1	1.2371
Benzyl propionate	4.0	1.0324
Benzyl butyrate	5.0	0.7738
Benzyl hexanoate	9.3	1.0646

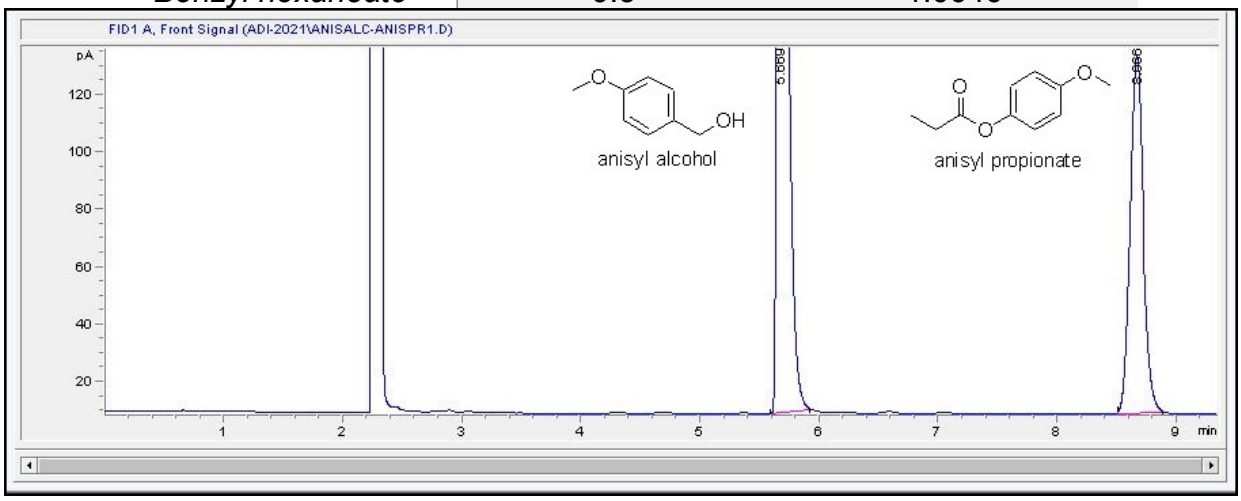

Figure S1. Chromatographic separation of anisyl alcohol and anisyl propionate.

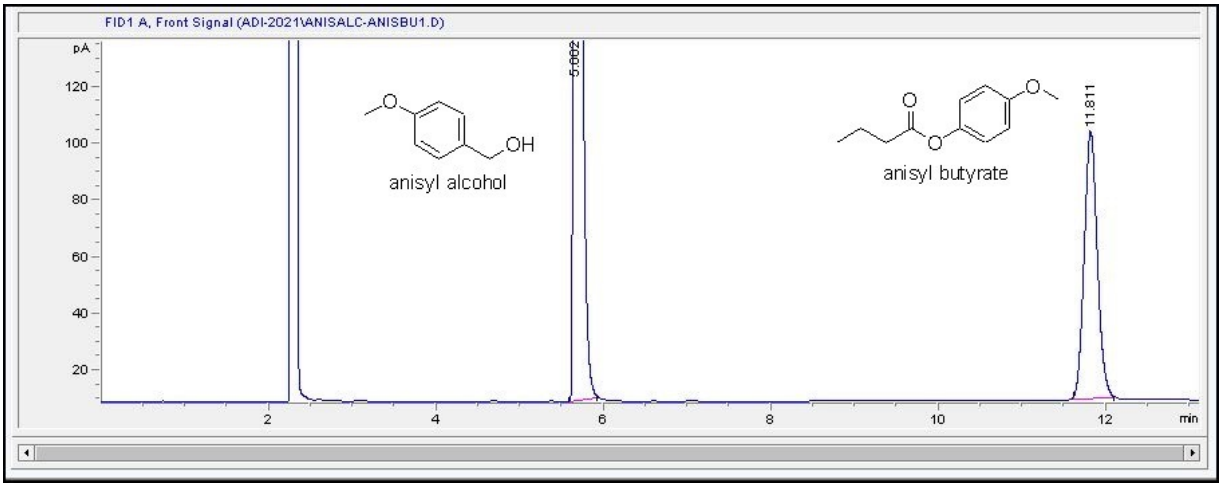

Figure S2. Chromatographic separation of anisyl alcohol and anisyl butyrate.

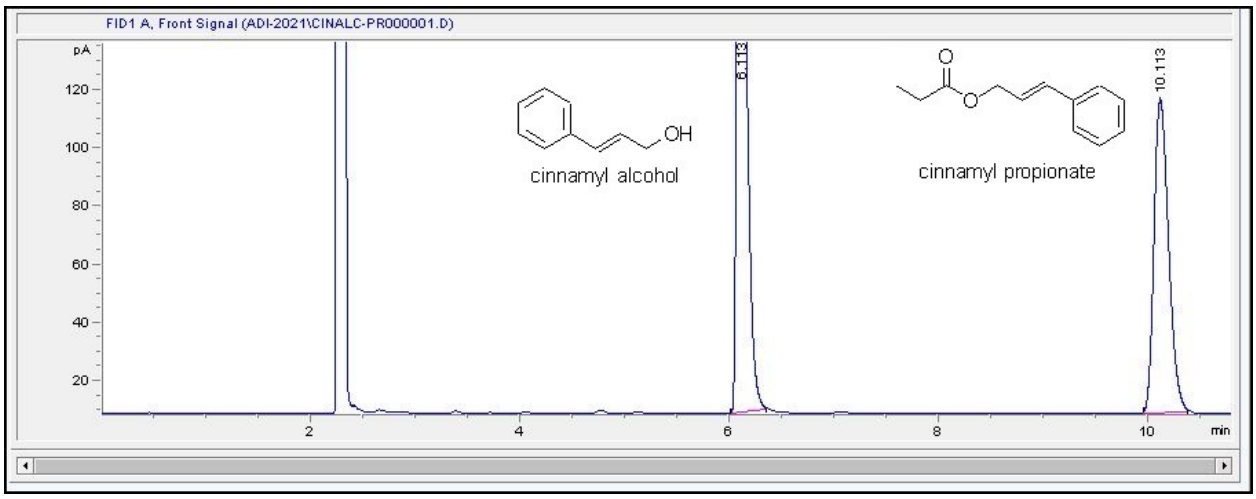

Figure S3. Chromatographic separation of cinnamyl alcohol and cinnamyl propionate.

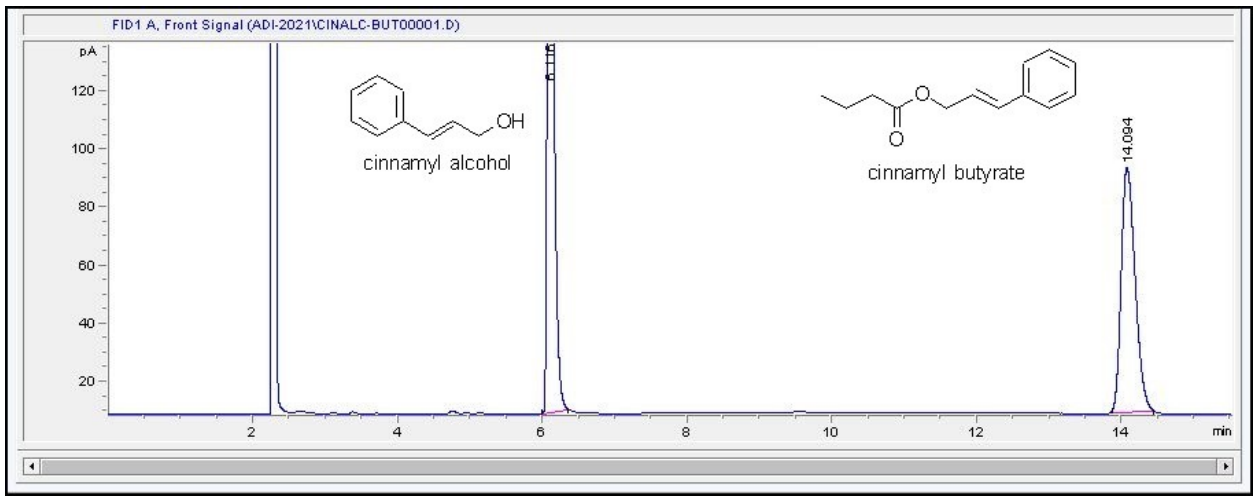

Figure S4. Chromatographic separation of cinnamyl alcohol and cinnamyl butyrate.

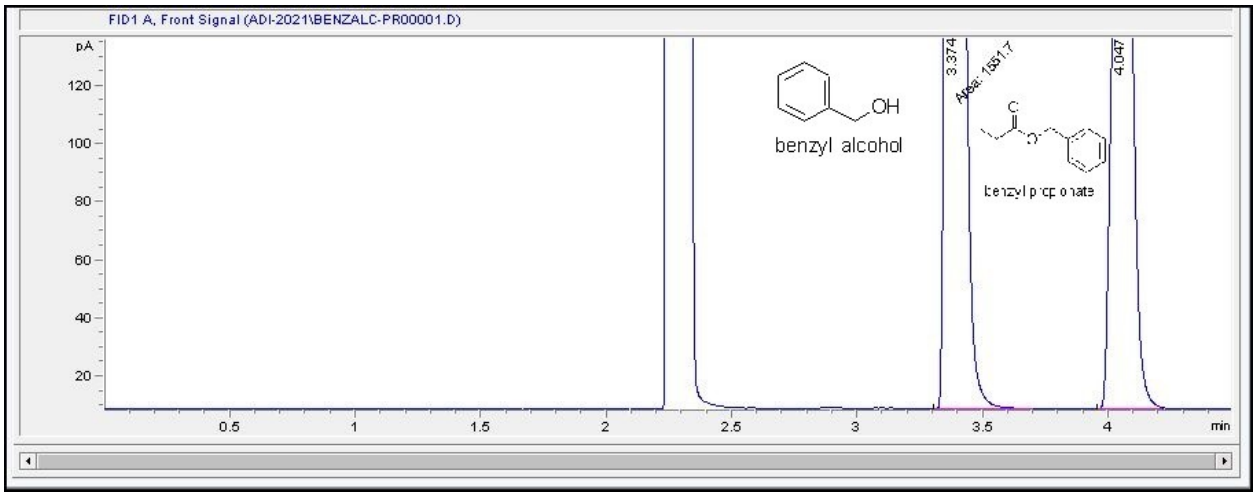

Figure S5. Chromatographic separation of benzyl alcohol and benzyl propionate.

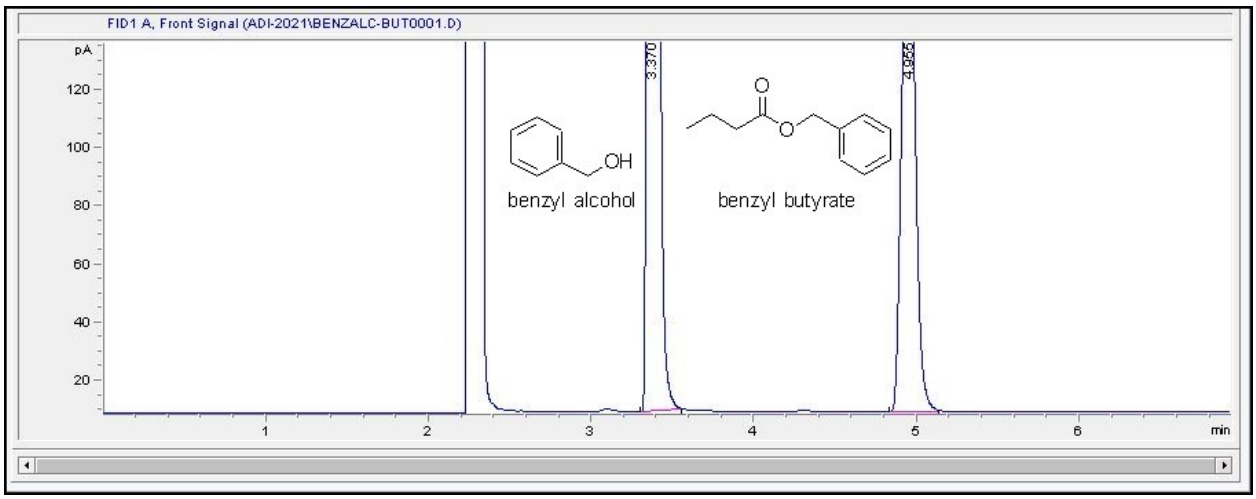

Figure S6. Chromatographic separation of benzyl alcohol and benzyl butyrate.

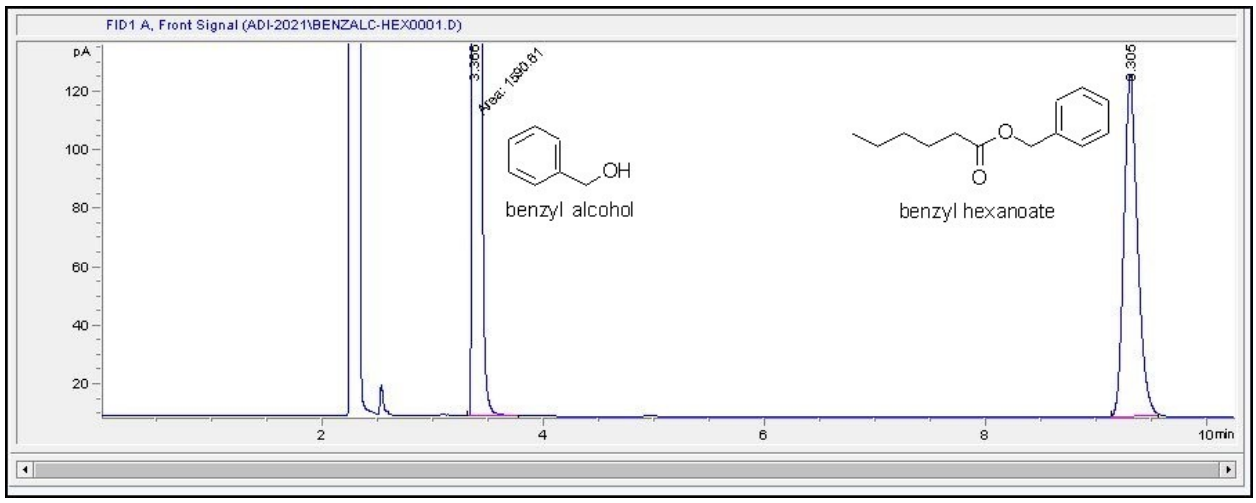

Figure S7. Chromatographic separation of benzyl alcohol and benzyl hexanoate.

Optimization of reaction system parameters by factorial design

Reaction system parameters were optimized for each desired ester individually using a response surface methodology (central composite model). For this, four parameters (alcohol: acid molar *ratio*, temperature, vacuum and reaction time) were chosen for optimization. An experimental matrix was constructed in order to set-up the experiments, and it contained factorial points, axial points and center points. Factorial and center points were analyzed in duplicate. The matrix that was used for optimization experiments, with categorical values for each factor, is presented in **Table S2**. Please note that there are 32 factorial points because each factorial point was performed in duplicate.

Table S2. Experimental matrix for optimizing reaction system parameters for the direct esterification of aromatic alcohols with short-chain acids.

Sample no.	*Type of sample*	*Molar ratio*	*Temperature [°C]*	*Vacuum [mbar]*	*Reaction time [min]*
1	Factorial	1:1	25	15	30
2		1:3	25	15	30
3		1:1	35	15	30
4		1:3	35	15	30
5		1:1	25	25	30
6		1:3	25	25	30
7		1:1	35	25	30
8		1:3	35	25	30
9		1:1	25	15	90
10		1:3	25	15	90
11		1:1	35	15	90
12		1:3	35	15	90
13		1:1	25	25	90
14		1:3	25	25	90
15		1:1	35	25	90
16		1:3	35	25	90
17		1:1	25	15	30
18		1:3	25	15	30
19		1:1	35	15	30
20		1:3	35	15	30
21		1:1	25	25	30
22		1:3	25	25	30
23		1:1	35	25	30
24		1:3	35	25	30
25		1:1	25	15	90
26		1:3	25	15	90
27		1:1	35	15	90
28		1:3	35	15	90
29		1:1	25	25	90
30		1:3	25	25	90
31		1:1	35	25	90
32		1:3	35	25	90
33	Axial	1:0.58	30	20	60
34		1:3.4	30	20	60
35		1:2	22.93	20	60
36		1:2	37.07	20	60
37		1:2	30	12.93	60
38		1:2	30	27.07	60
39		1:2	30	20	17.57
40		1:2	30	20	102.43
41	Center	1:2	30	20	60
42		1:2	30	20	60