Explanation of the Mass that is left over from Distillation of 4 resins that were tested

Frankincense Species Boswellia papyrifera, Boswellia serrata, Boswellia sacra, Boswellia carterii

Dissertation by Michael Paul (A Qualitative and Quantitative Approach by Chromatographic and Spectroscopic Methodology Saarland University Saarbrücken, Saarland, Germany 2012

Explained to me by Hubert Marceau

(Most of the technical terms and writing in here are Hubert's words and I had his full permission to use them)

I have recently distilled Frankincense Boswellia Carterri and was left with this beautiful mass as you see below. I wanted to learn what is left in this that can be used besides the essential oil and hydrosol that came out of the distillation.

We know that Boswellic Acid in these 4 resins does not go into the distillation because the molecules in the Ba are too heavy to pass through but what else stays back if any?

I went to Hubert because he is a known scientist and chemist and knows so much about essential oils for my explanation.

He told me the reason why the BA does not pass through distillation is due to the low volatility. Volatility being the affinity for molecules with their environment and their propension to turn from solid/liquid to gas phase. This loosely correlates with polarity and molecular weight. This is why an essential oil has mainly low molecular weight, non polar molecules.

The second concept here is solubility, which is the one for carrier oil (when we infuse the resin in a carrier oil, I asked him how the BA does come out into the infused carrier oil)

The concept here is "Like like like", similar polarity compound will be dissolved in similar polarity solvent

Polarity is a concept similar to magnetism, molecule will have electron going in their structure and depending on how the atom are arranged some will pull more, thus creating higher density electron pool
This act like small magnet that can fit one into another like fridge magnet (with a positive and negative pole)
Water is very polar, the electron pooling around the oxygen atom

Boswellic acid is not very polar, the large triterpenic part being like a desert since carbon tend to be more or less "meh" on electron pulling
The few oxygen atom there and here have little impact on the large pool of neutrality

This is why we say the molecule is mainly non polar
So a non polar molecules (BA) will have poor solubility in a polar solvents (water) but a better solubility in a non-polar solvent (carrier oil)
That being said, Boswell acid to have an acid moiety, and by playing by pH we can probably end up being able to solubilize it in water but this is a lot more complex to predict.

After the distillation of the resin there should be no too few volatile left after distillation, but what is left can be quite complex. The more you dig the more you find.

In the picture below are all sub product found in the 4 resins that were tested.. tirucalic acid, boswellic acid, and their precursor. It is a small sub fraction of the compound. I asked him what are the rest since the molecules here look so complex.

He told me there are way too many compounds in nature to know all their usage Tirucalic acid is usually found in Boswellic Acid from the info he has seen.

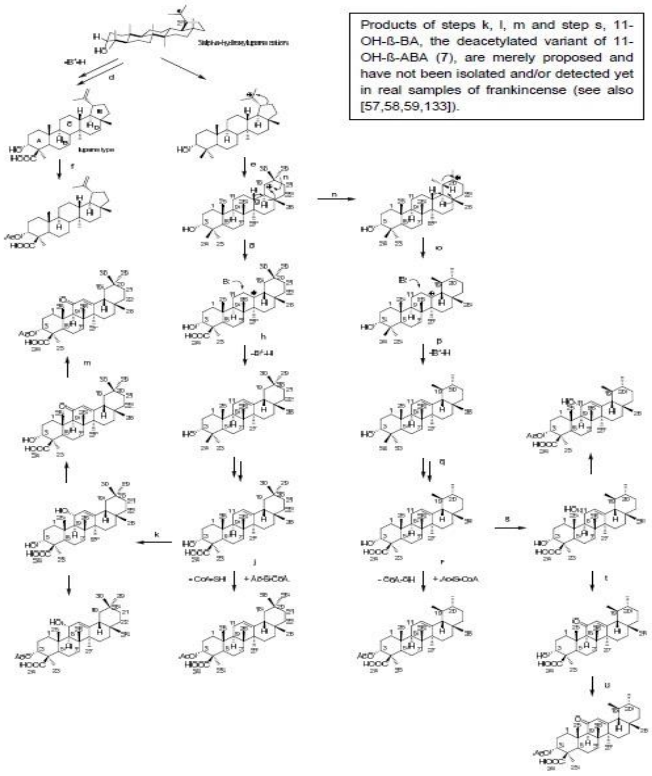

Fig. 3.127 Scheme for the biosynthesis of LAs (**11** and **12**) and BAs (**1-7**) beginning from the 3α-hydroxylupane cation as probable precursor. For details see text.

These are the breakdowns of the TA in the Mass. This one shows what is inside the. tirucalic acid,

Compound	5	6	15	14	13	16	1 (2D)	3 (2D)	11	12	2	4	22	23	21	20	24	28
Bpap-Seitz	1,0	13,1	2,1	1,8	7,3	2,7	3,5	4,2	0,4	1,6	6,0	10,7	24,9	18,5	0,0	0,0	1	0
Bpap-MP-0409	2,0	13,1	3,5	2,6	8,8	3,5	3,3	5,4	0,7	1,6	6,1	10,6	23,0	16,7	0,0	0,0	1	0
Bpap-AS-070509-A2b	1,4	15,3	2,5	2,1	9,1	2,3	3,5	5,7	1,0	1,8	6,9	8,5	19,6	15,2	0,0	0,0	1	0
Bpap-AS-260309-A1c	1,0	14,8	1,8	1,1	5,5	1,3	2,3	5,2	0,4	1,2	5,5	9,1	18,8	14,0	0,0	0,0	1	0
Bpap-AS-090610-F1a	1,2	16,3	3,3	3,1	12,8	4,7	4,2	7,4	1,2	1,5	6,7	10,2	22,9	16,2	0,0	0,0	1	0
Bpap-AS-060910-F1a	1,3	11,6	3,6	3,3	22,7	4,7	4,5	8,0	0,7	1,7	7,4	11,4	23,1	18,6	0,0	0,0	1	0
Bpap-AS-220509-A1c	1,0	11,0	2,1	1,3	6,2	1,4	2,8	5,1	0,4	1,2	5,6	9,3	25,0	16,6	0,0	0,0	1	0
Bpap-Caelo-Pr	1,2	15,6	4,0	3,3	15,8	3,7	4,6	11,0	0,7	1,8	7,4	13,6	15,3	10,9	0,0	0,0	1	0
Bpap-22-1300	1,2	16,5	3,5	3,6	14,2	4,0	4,5	8,9	0,7	1,8	7,6	13,0	21,3	13,2	0,0	0,0	1	0
Bpap-22-1400	1,0	16,0	3,4	2,8	14,2	3,9	4,2	9,2	0,6	2,0	8,1	15,0	16,1	11,9	0,0	0,0	1	0
Bser-AS-240309-A3c	1,6	2,5	4,3	3,8	10,5	3,5	5,3	14,3	1,1	1,0	4,0	13,6	2,5	0,0	16,8	3,1	0	0
Bser-AS-190409-A3b	1,8	2,9	4,3	4,4	10,5	3,9	6,8	15,0	1,1	1,5	4,4	14,9	0,9	0,0	5,3	0,9	0	0
Bser-AS-110809-A3c	1,5	2,5	4,9	5,9	11,5	3,6	6,8	16,1	1,0	1,0	4,2	14,2	2,2	0,0	14,2	2,6	0	0
Bser-AS-060910-F3a	2,4	2,9	4,2	5,8	9,7	3,2	7,2	17,5	1,5	0,3	4,1	13,6	2,4	0,0	4,1	0,7	0	0
Bser-AS-060810-F3b-RS	2,2	2,9	4,3	5,5	11,7	4,1	8,4	18,3	1,3	1,0	4,5	15,1	1,6	0,0	11,2	2,2	0	0
Bser-siccum 96 % EtOH-a	2,4	2,9	4,4	5,1	11,5	3,5	8,0	17,1	1,4	1,1	4,3	14,5	2,0	0,0	3,0	0,6	0	0
Bser-siccum 96 % EtOH-b	2,4	2,9	4,3	5,1	11,7	3,3	8,1	17,1	1,3	1,2	4,5	14,7	2,2	0,0	2,0	0,8	0	0
Bser-siccum 96 % EtOH-c	3,0	3,4	3,2	2,9	7,7	0,6	8,6	18,7	1,3	1,1	4,6	15,2	2,1	0,0	2,3	1,4	0	0
Bser-Art. No. 22.127	3,0	3,0	4,0	5,4	10,8	3,0	8,5	18,8	1,5	0,9	3,9	12,4	4,0	0,0	9,1	1,7	0	0
Bser Granen	2,7	4,1	3,2	3,8	8,4	2,5	8,0	16,0	1,4	1,5	4,5	13,4	0,0	0,0	6,0	1,0	0	0
Bser-No. 22-1560	1,8	3,1	5,3	7,1	16,3	4,2	7,6	17,6	1,3	1,2	4,6	15,0	0,0	0,0	5,1	0,4	0	0
Bser-Gufic, AB0918	6,7	4,6	5,7	9,1	17,2	3,3	10,7	20,9	1,8	1,0	4,2	13,3	0,0	0,0	15,7	3,1	0	0
Bser-Gufic, AB0919	7,1	4,4	5,8	10,4	15,6	3,0	10,6	19,6	2,0	1,4	3,8	12,7	0,0	0,0	15,9	3,1	0	0
Bser-Gufic, AB0920	5,7	4,1	4,4	6,7	9,9	2,3	9,1	17,1	1,7	0,9	3,5	11,4	0,0	0,0	9,1	1,7	0	0
Bcar-RS (AK Jauch)	0,9	2,2	1,5	3,0	1,4	0,7	7,5	13,7	2,8	3,8	7,2	13,6	0,0	0,0	1,0	0,3	0	1
Bcar-AS-050910-A11c	0,2	2,3	1,1	1,7	2,1	1,2	4,6	10,4	2,2	4,0	7,9	16,7	5,2	0,0	2,6	0,7	0	1
Bcar-AS-040910-F11a	0,3	2,1	1,3	0,9	2,0	0,9	6,9	16,3	2,9	6,1	11,2	23,7	5,8	0,0	2,9	0,8	0	1
Bcar-22-1238	0,5	11,1	1,3	1,1	2,3	0,9	8,4	17,0	2,1	6,1	14,1	27,9	11,4	0,0	4,5	0,8	0	1
Bcar-Giama	0,5	12,7	0,7	0,5	0,9	0,2	12,1	22,5	4,2	3,9	11,1	15,6	5,6	0,0	3,6	0,4	0	1
Bcar-Aden, Schreibmayer	0,6	1,8	1,2	0,9	1,7	0,7	6,4	15,6	2,6	5,6	10,1	23,1	1,2	0,0	1,9	0,0	0	1
Bsac-AS-040910-A10a	0,5	2,5	1,5	1,1	2,0	1,1	7,3	14,3	2,8	6,7	11,5	23,5	2,7	0,0	10,3	1,3	0	1
Bsac-22-1232	0,1	0,1	0,5	1,5	0,2	0,1	10,8	22,6	4,4	5,6	12,8	22,8	1,9	0,0	8,8	3,0	0	1
Bsac-JB03 Pr 55	1,1	20,0	1,5	1,8	2,9	1,3	4,5	5,1	1,8	5,4	13,2	10,5	0,0	0,0	0,5	0,0	0	1
Bsac-Dr. Mohsin Pr. 6	1,1	15,0	1,2	0,4	1,0	0,3	2,8	5,4	0,8	1,5	4,9	6,9	0,0	0,0	14,0	1,6	0	1

This one shows more of the breakdown of the TA

Tab. 3.27 The arithmetically averaged measurement results for the RS acid fraction (S.D. = standard deviation, random sample; n = numbers of different resin batches analysed; #NV = not detectable). Since Bcar and Bsac can be considered the same species, their data was combined to Bsac/Bcar.

		n = 6		n = 4		n = 10		n = 14		n = 10	
Compound	**Nr.**	**Bcar** [g/g in %]	**S.D.**	**Bsac**	**S.D.**	**Bpap** [g/g in %]	**S.D.**	**Bser** [g/g in %]	**S.D.**	**Bsac/Bcar** [g/g in %]	**S.D.**
ß-KBA	**5**	0.48	0.25	0.64	0.43	1.22	0.30	3.16	0.52	0.56	0.34
ß-AKBA	**6**	5.38	5.09	8.03	8.88	14.33	1.98	3.28	0.43	6.70	6.98
11-OH-ß-ABA	**7**	3.60	1.70	6.22	6.44	4.41	3.04	2.37	0.70	4.91	4.07
ß-OH-TA	**15**	1.20	0.28	1.20	0.43	2.98	0.77	4.44[a]	0.63	1.20[a]	0.35
α-OH-TA	**14**	1.33	0.91	1.45	0.75	2.47	0.89	5.77[a]	1.18	1.39[a]	0.83
3-O-TA	**13**	1.73	0.51	1.64	1.05	11.66	5.31	11.64	2.23	1.68	0.78
α-Ac-TA	**16**	0.75	0.33	0.71	0.52	3.21	1.25	3.13	1.00	0.73	0.43
α-BA	**1**	7.78	2.60	6.45	3.00	3.72	0.76	8.32	0.91	7.11	2.80
α-BA (2D)	**1**	7.64	2.52	6.40	3.01	3.73	0.77	8.12	1.10	7.02	2.76
ß-BA	**3**	15.94	3.83	12.19	7.27	9.21	1.66	19.45	1.48	14.07	5.55
ß-BA(2D)	**3**	15.92	4.00	12.15	7.25	7.01	1.37	17.43	1.55	14.04	5.62
11-Ome-ß-ABA	**8**	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV
LA	**11**	2.78	0.75	2.51	1.33	0.68	0.26	1.41	0.18	2.64	1.04
Ac-LA	**12**	4.89	1.13	5.04	2.04	1.81	0.27	1.07	0.31	4.97	1.58
9,11-Dehydro-ß-ABA	**10**	0.02	0.02	0.35	0.52	1.57	1.96	0.21	0.77	0.18	0.27
α-ABA	**2**	10.25	2.49	10.60	3.32	6.73	0.88	4.21	0.25	10.43	2.91
ß-ABA	**4**	20.08	5.59	17.18	7.84	11.13	2.11	13.83	0.89	18.63	6.72
Sum[b]:		76.21		74.20		72.94		77.33		75.21	
Unknown Rest:		23.79		25.80		27.06		22.67		24.79	

[a] Values of **14** and **15** in Bser and Bsac/Bcar are actually too high (Co-elution with **21** and **20**, see also 3.7.2 – 3.7.4).
[b] The 2D contents of ß-BA have been used for summation.

This is another version:

Tab. 3.27 The arithmetically averaged measurement results for the RS acid fraction (S.D. = standard deviation, random sample; n = numbers of different resin batches analysed; #NV = not detectable). Since Bcar and Bsac can be considered the same species, their data was combined to Bsac/Bcar.

		n = 6		n = 4		n = 10		n = 14		n = 10	
Compound	**Nr.**	**Bcar** [g/g in %]	**S.D.**	**Bsac**	**S.D.**	**Bpap** [g/g in %]	**S.D.**	**Bser** [g/g in %]	**S.D.**	**Bsac/Bcar** [g/g in %]	**S.D.**
ß-KBA	**5**	0.48	0.25	0.64	0.43	1.22	0.30	3.16	0.52	0.56	0.34
ß-AKBA	**6**	5.38	5.09	8.03	8.88	14.33	1.98	3.28	0.43	6.70	6.98
11-OH-ß-ABA	**7**	3.60	1.70	6.22	6.44	4.41	3.04	2.37	0.70	4.91	4.07
ß-OH-TA	**15**	1.20	0.28	1.20	0.43	2.98	0.77	4.44[a]	0.63	1.20[a]	0.35
α-OH-TA	**14**	1.33	0.91	1.45	0.75	2.47	0.89	5.77[a]	1.18	1.39[a]	0.83
3-O-TA	**13**	1.73	0.51	1.64	1.05	11.66	5.31	11.64	2.23	1.68	0.78
α-Ac-TA	**16**	0.75	0.33	0.71	0.52	3.21	1.25	3.13	1.00	0.73	0.43
α-BA	**1**	7.78	2.60	6.45	3.00	3.72	0.76	8.32	0.91	7.11	2.80
α-BA (2D)	**1**	7.64	2.52	6.40	3.01	3.73	0.77	8.12	1.10	7.02	2.76
ß-BA	**3**	15.94	3.83	12.19	7.27	9.21	1.66	19.45	1.48	14.07	5.55
ß-BA(2D)	**3**	15.92	4.00	12.15	7.25	7.01	1.37	17.43	1.55	14.04	5.62
11-Ome-ß-ABA	**8**	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV
LA	**11**	2.78	0.75	2.51	1.33	0.68	0.26	1.41	0.18	2.64	1.04
Ac-LA	**12**	4.89	1.13	5.04	2.04	1.81	0.27	1.07	0.31	4.97	1.58
9,11-Dehydro-ß-ABA	**10**	0.02	0.02	0.35	0.52	1.57	1.96	0.21	0.77	0.18	0.27
α-ABA	**2**	10.25	2.49	10.60	3.32	6.73	0.88	4.21	0.25	10.43	2.91
ß-ABA	**4**	20.08	5.59	17.18	7.84	11.13	2.11	13.83	0.89	18.63	6.72
Sum[b]:		76.21		74.20		72.94		77.33		75.21	
Unknown Rest:		23.79		25.80		27.06		22.67		24.79	

[a] Values of **14** and **15** in Bser and Bsac/Bcar are actually too high (Co-elution with **21** and **20**, see also 3.7.2 – 3.7.4).
[b] The 2D contents of ß-BA have been used for summation.

So in conclusion, there is lots of Boswellic Acid left over in the pure resin. How much is not exactly sure but given that there is a large percentage of TA in it besides the Boswelic acid it would seem there is a great amount. The resin mass is water and alcohol soluble so it melts easy. It can be used in creams and lotions for skin conditions and infused in a carrier oil. Given it has BA in it, you may powder it down and ingest it also but that you do at your own risk mainly because no one knows what the other components are in it. That would take lots of testing and lots of money to do it. The full version of this dissertation can be found in our files and it is called **Dissertation_Fertig_211112.pdf.**

I took 40 grams to 8 oz of fractionated coconut oil (FCO) and infused it in a double boiler warm bath method. I then let it sit for 5 days more prior to straining. I found I had only about a teaspoon left of the leftover mass. That teaspoon was mushy and melted in my fingers. What you see below are pictures of it. It smells wonderful, has a nutty type smell, very earthy. Because it has mostly BA in it I plan on using it in lotions and cremes for skin conditions or any inflammation on the skin

I know you are going to ask me- How about the resins that have no BA in it?
Those have not been tested and as I said it is very expensive to test. I do know some of it is being used. Boswellia Frereana's left overs are being used in Arabic countries for the making of chewing gum. It seems it helps with digestion and mouth issues. So some chemical components in it must have some therapeutic properties. Until someone has the money to test it we will never know.

But it does show that all the resin distillation has a purpose, Essential Oil, Hydrosol, and the left over mass. Nothing is wasted!

Thank You Hubert for explaining all this to me ☺