

Optimization of cinnamon (*Cinnamomum verum* J. Presl.) essential oils extraction using hydrodistillation (Clevenger apparatus)

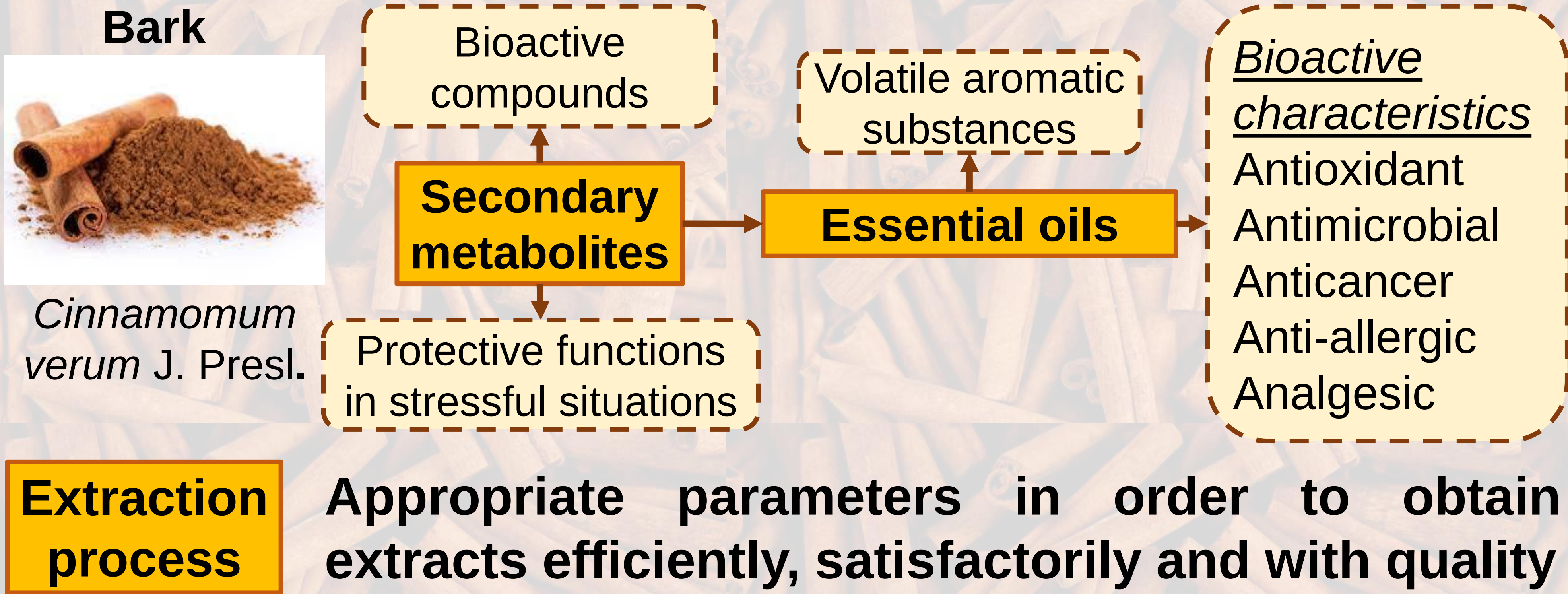
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Introduction



Results

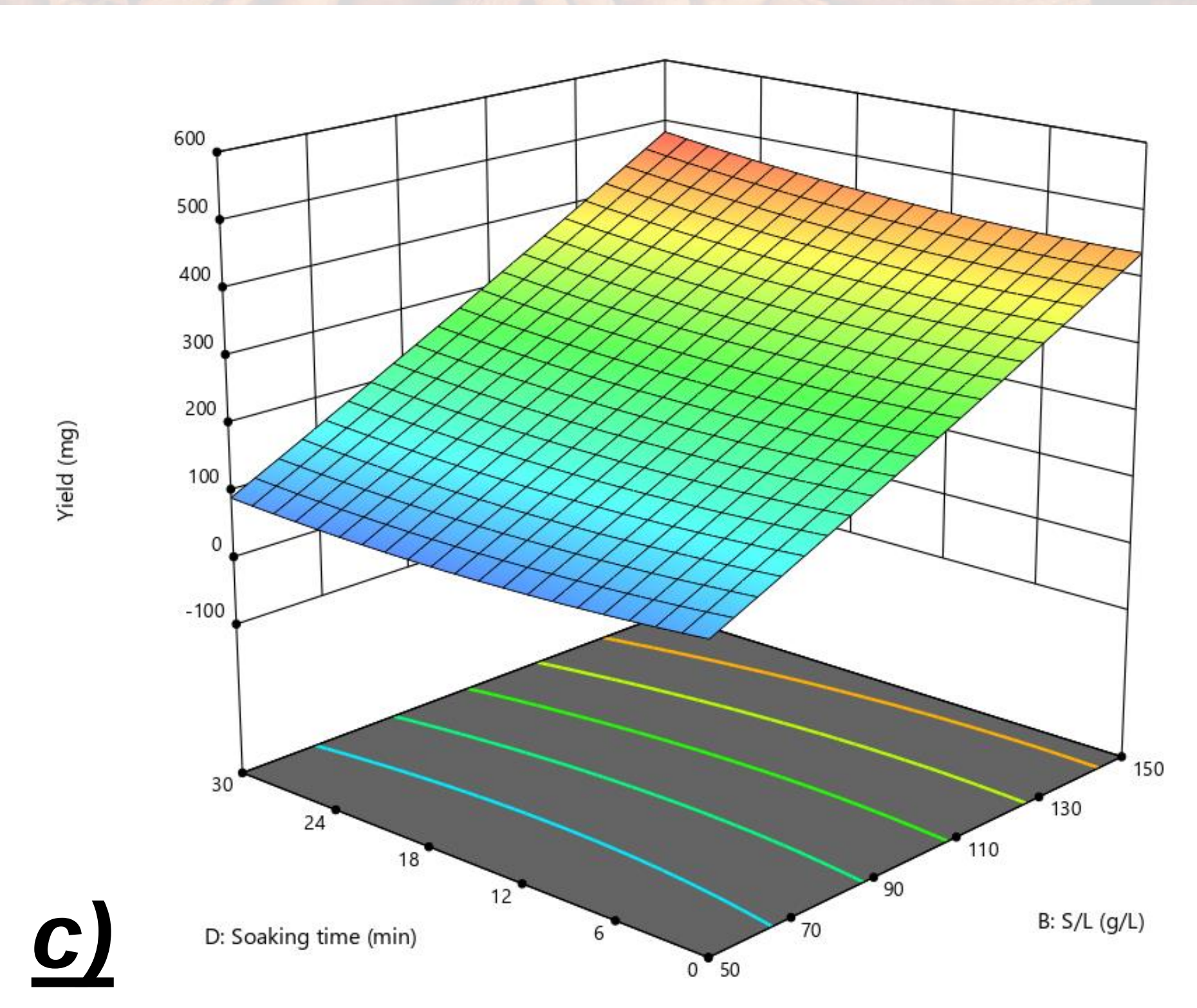
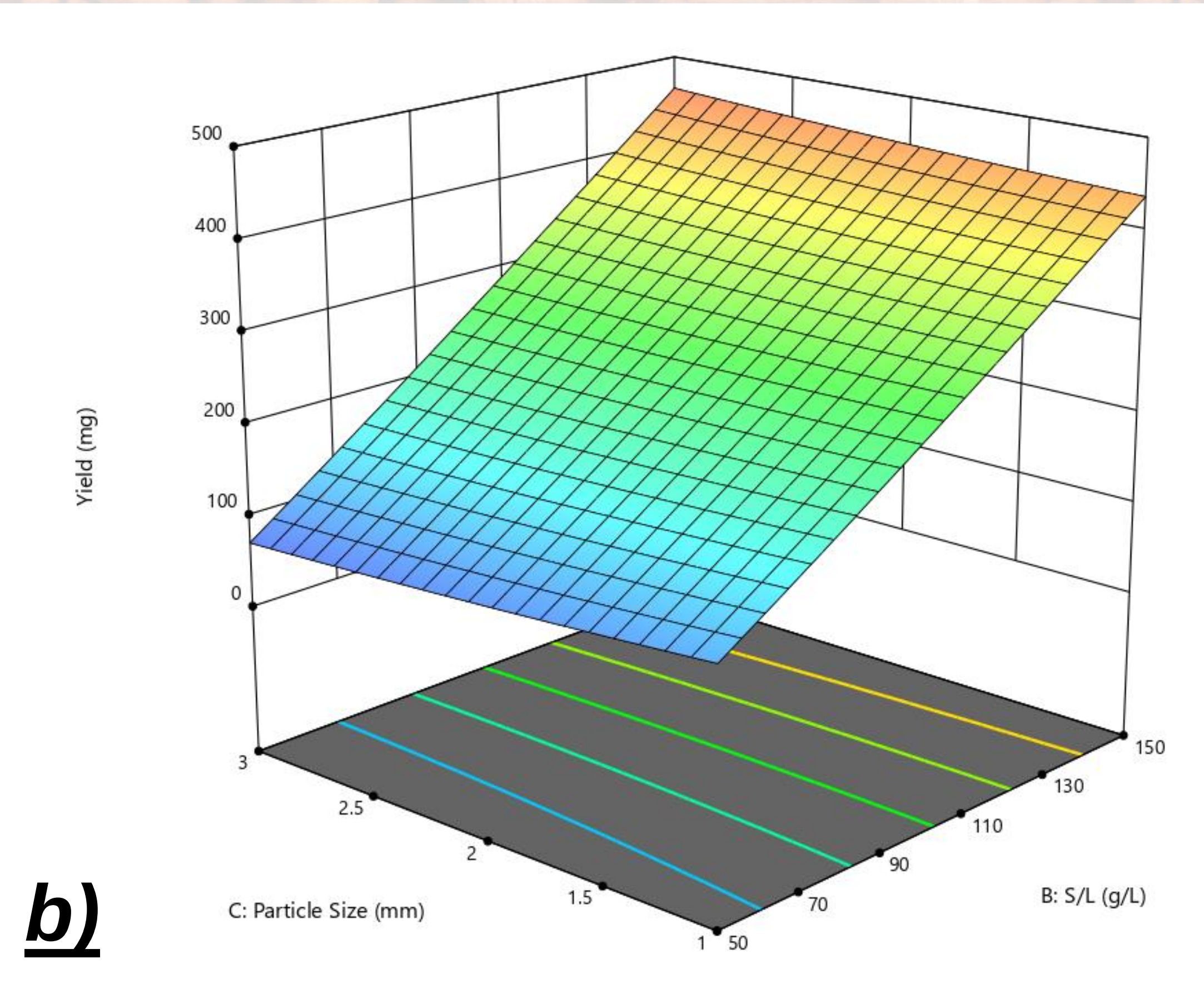
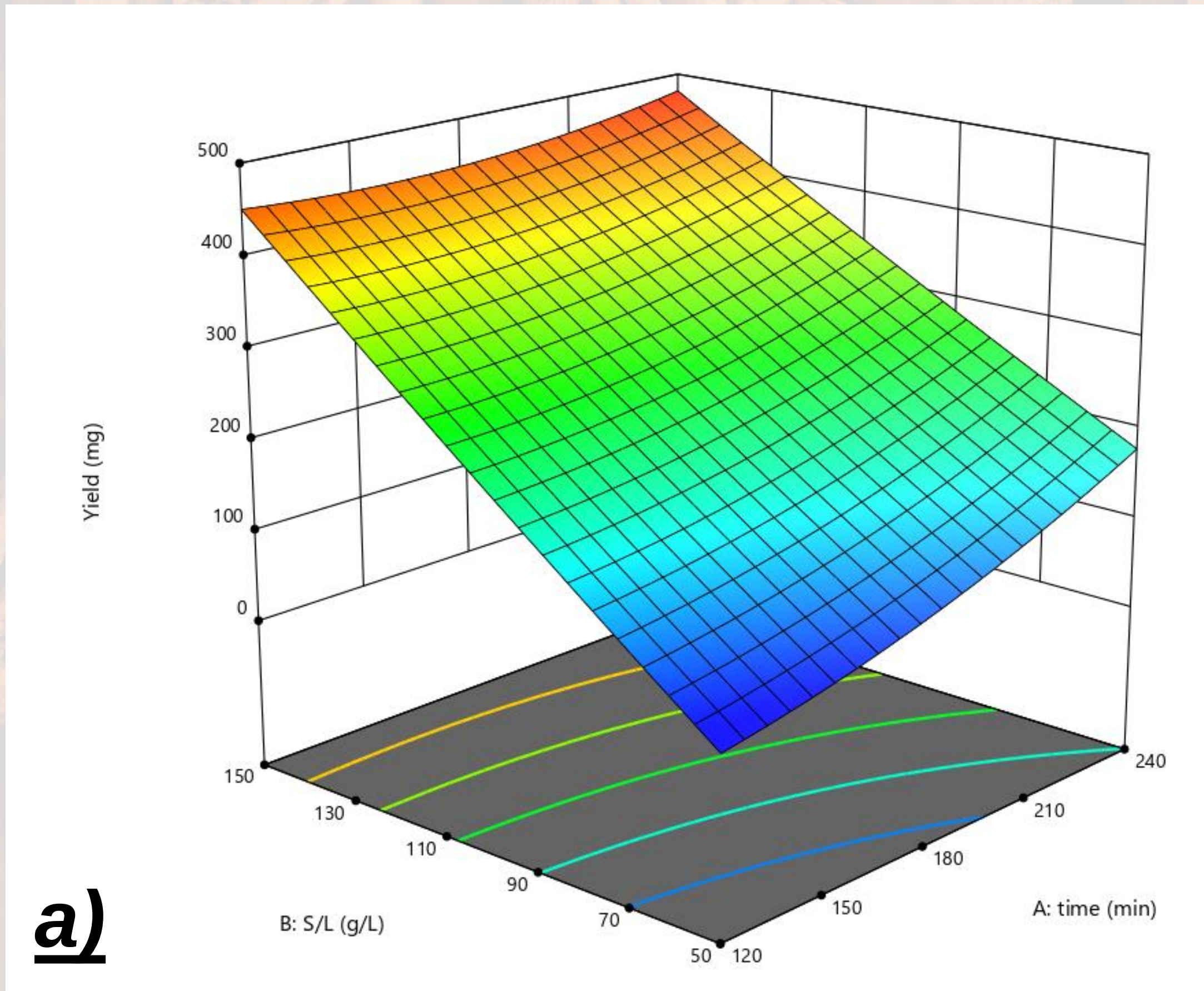


Figure 1 – 3D graph of a) ratio vs time; b) soaking time vs ratio; c) particle size vs ratio and the response in weight (mg).

Yield range (Y1): 47.6-494.9 mg of oil

Significant variables:

- ↑ Ratio ↑ Yield
- ↑ Time ↑ Yield

Conclusion

- Despite not having found the maximum point, it was possible to perceive a direct tendency of proportionality between concentration, time and yield;
- Soaking time and particle size did not influence the study significantly, therefore, they are not interesting to be used as variables;
- Future studies – Analyse the phenolic compounds content.

Methodology

Response surface methodology (RSM)

Box Behnken design

4 Factors:

- Time (F1)
- Ratio (F2)
- Particle size (F3)
- Soaking time (F4)

Hydrodistillation



Response: Yield (Y1)



Run	Time (min)	Ratio (g/L)	Particle Size (mm)	Soaking time (min)
1	180	150	3,5	15
2	180	50	3,5	15
3	120	100	3,5	15
4	180	100	1	0
5	120	100	1	15
6	180	50	2	30
7	120	50	2	15
8	180	150	2	30
9	240	100	2	30
10	240	50	2	15
11	120	150	2	15
12	180	100	2	15
13	180	100	2	15
14	180	150	1	15
15	240	100	1	15
16	180	100	3,5	30
17	120	100	2	0
18	240	100	2	0
19	180	100	2	15
20	180	150	2	0
21	240	150	2	15
22	180	100	2	15
23	240	100	3,5	15
24	180	100	3,5	0
25	180	100	1	30
26	180	50	2	0
27	120	100	2	30
28	180	50	1	15
29	180	100	2	15

Table 1 – Experimental design applied for optimization

Acknowledgments

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Time	238 min
Ratio	148 g/L
Particle Size	2 mm
Soaking time	26 min

Table 2 – Optimal point

The coded values analysis:

- Design Expert software, using a quadratic model;
- The model showed a significant fit and an insignificant lack of fit.