This document was prepared by Hasan Basri ÖKSÜZ and Sencer BUZRUL for describing the use of ÖK-BUZ GRoFiT (Öksüz-Buzrul microbial growth modeling tool) application.

IF YOU USE ÖK-BUZ GROFIT TOOL IN YOUR RESEARCHES, STUDIES, PROJECTS ETC., PLEASE CITE THE FOLLOWING ARTICLE (IN TURKISH WITH AN ENGLISH ABSTRACT): "Öksüz, H.B, Buzrul, S. (2021). An Excel-based, User-friendly Freeware Tool to Describe Microbial Growth Curves: ÖK-BUZ GROFIT. Journal of Tekirdağ Agricultural Faculty, 18(3): 521-532. DOI: 10.33462/jotaf.853435"

IMPORTANT REMARK: "Solver" Add-In should be installed in Excel in order to use ÖK-BUZ GRoFiT. Please click File > Options > Add-Ins > Excel Add-Ins "Go" > Select Solver and Click OK. Solver will be available under "Data" in Excel. You can also refer related websites showing how to install Solver in Excel.

ÖK-BUZ GRoFiT v2.0 is both available in Turkish and English. On the other hand, ÖK-BUZ GRoFiT v1.0 is only available in Turkish. The difference between two versions is the calculation of standard errors of the model parameters: v1.0 uses Monte Carlo analysis (100 simulations are done and it takes 10 to 40 seconds for this calculation), v2.0 uses variance-covariance matrix and calculations are almost instantaneous.

Below the use of ÖK-BUZ GRoFiT v2.0 is simply shown.

- 1. Download the application.
- 2. Open the file.
- 3. Sample dataset will appear (Fig. 1). You may also enter your own data.

1	А	В	С	D	E	F
1	Time	log ₁₀ N				
2	0	2.88				
3	3	2.82				
4	5	2.64				
5	6	3.29		Ope		
6	7	3.42		inte		
7	9	4.67				
8	11	5.25				
9	13	6.37		Please		
10	15	7.5		your		
11	16	7.68		starting		
12	20	8.46		and		
13	24	8.13				
14						
15						
16						
17						
18						
19						
20						
]	Fig 1. S	plash scre	en of	ÖK-BUZ	GRoFiT	v2.0

- 4. Click "Open the interface".
- 5. Select a model (Fig. 2).

	А	В	С	D	E	F	G	н	1	J	к	L	M	N
1	Time	log ₁₀ N			C								2	
2	0	2.88							ÖK-BUZ GRoFiT					×
3	3	2.82												
4	5	2.64							Model	Selection 💌	Model	fit 🔽	Confidence	
5	6	3.29		Ope	en the				G	Baranyi Sompertz			ATTOUT Y GIT	
6	7	3.42		inte	erface					TPL		KONVA		
7	9	4.67							F000 8	& AGRICULTURE		GIDA VE	TARIM	
8	11	5.25							U	NIVERSITY		UNIVER	SITESI	
9	13	6.37		Please	e enter						2013		Created by	
10	15	7.5		you	r data								Sencer BUZRI	
11	16	7.68		starting	from A2							н	lasan Basri ÖK	SÜZ
12	20	8.46		and	d B2!									
13	24	8.13												
14														
15														
16														
17														
18														
19														
20														

Fig 2. Microbial growth models in the interface of ÖK-BUZ GRoFiT v2.0

- 6. Click "Model fit".
- 7. Results appear as in Fig. 3. Parameter estimates, standard errors of the parameters and goodness-of-fit indices (R^2 , R^2_{adj} , RMSE) are given. Besides, if parameters are statistically significant ($p \le 0.05$) they are marked as "significant" if not (p > 0.05) marked as "insignificant". Model's fit and experimental data are shown in a graph. Each model's results will be shown in a separate workbook.

-	Α	В	С	D	G	н	I	J	К	L	М	0	Р
1	Time	log ₁₀ N	Model	Squared of Differences		Parameters	Parameter Estimates	Standard Error	Significant - Insignificant			Goodness-of-fit-indices	
2	0	2.8800	2.7652	0.0132		log ₁₀ N ₀	2.77	0.13	Significant			RMSE	0.1924
3	3	2.8200	2.7836	0.0013		log10Nmaks	8.29	0.14	Significant			R ²	0.9948
4	5	2.6400	2.9256	0.0816		Hmaks	1.1530	0.0633	Significant			Adjusted R ²	0.9928
5	6	3.2900	3.1489	0.0199		λ	5.70	0.50	Significant				
6	7	3.4200	3.5055	0.0073					- 0				
7	9	4.6700	4.4294	0.0579			Baranyi Model						
8	11	5.2500	5.4218	0.0295	1000000		Daranyi Wouci						
9	13	6.3700	6.4172	0.0022	10.0000								
10	15	7.5000	7.3692	0.0171	9.0000 -								
11	16	7.6800	7.7699	0.0081	8.0000 -			-					
12	20	8.4600	8.2820	0.0317	7.0000		1						
13	24	8.1300	8.2918	0.0262	2 6 0000								
14			ΣSquared of Differences:	0.2961	0.0000				• Data				
15					5.0000 -		9	_	Model				
16					4.0000 -	/							
17					3.0000 🖕								
18					2.0000								
19					0	5	10 15 20	25					
20							Time						
21								1					
	4 >		Page1 Baranvi1	(+)									

Fig. 3. Results of the selected model for ÖK-BUZ GRoFiT v2.0

8. If the user wants to see the model's fit 95% confidence intervals on the same graph, he/she should click on the box "Confidence Interval" before closing the interface. Then approximate confidence intervals will appear on the graph together with the model fit (Fig. 4).



Fig 4. Confidence intervals of the model fit

References

- Baranyi, J., Roberts, T.A. (1994). A dynamic approach to predicting bacterial growth in food. *International Journal of Food Microbiology*, 23: 277-294.
- Buchanan, R.L., Whiting, R.C., Damert, W.C. (1997). When is simple good enough: a comparison of the Gompertz, Baranyi, and three-phase linear models for fitting bacterial growth curves. *Food Microbiology*, 14: 313-326.
- Öksüz, H.B, Buzrul, S. (2021). An Excel-based, User-friendly Freeware Tool to Describe Microbial Growth Curves: ÖK-BUZ GRoFiT. Journal of Tekirdağ Agricultural Faculty, 18(3): 521-532
- Zwietering, M.H., Jongenburger, I., Rombouts, F.M., Van't Riet, K. (1990). Modelling of the bacterial growth curve. *Applied and Environmental Microbiology*, 56: 1875–1881.