

Cost-Effective Eggshell-Modified LDH Composite for Caffeine Adsorption, cytotoxicity and Antimicrobial Activity: Exploring the Synergy and Economic Viability in Search Processes

Asmaa Elrafey¹, Ahmed A. Farghali², W. Kamal³, Ahmed A. Allam^{4,5}, Zienab E. Eldin², Hassan A. Rudayni⁴, Haifa E. Alfassam⁶, Alaa A. A. Anwar³, Sara Saeed³, Rehab Mahmoud^{3*}

¹ Environmental Science and Industrial Development Department, Faculty of Postgraduate Studies for Advanced Sciences, Beni-Suef University, Beni-Suef, Egypt. Asmaa_elrafey@hotmail.com

² Materials Science and Nanotechnology Department, Faculty of Postgraduate Studies for Advanced Science (PSAS), Beni-Suef University, Beni-Suef 62511. Ahmedfarghali74@yahoo.com, t-zienabessam@zewailcity.edu.eg.

³ Chemistry Department, Faculty of Science, Beni-Suef University, Beni-Suef 62511, Egypt. rehabkhaled@science.bsu.edu.eg; Sarasaeedabdelazeem@gmail.com, Wesamkamal16@yahoo.com.

⁴ Department of Biology, College of Science, Imam Muhammad Ibn Saud Islamic University, Riyadh 11623, Saudi Arabia HARUDAYNI@imamu.edu.sa

⁵ Department of Zoology, Faculty of Science, Beni-suef University, Beni-suef 65211 Egypt. Ahmed.aliahmed@science.bsu.edu.eg

⁶ Department of Biology, college of Science, Princess Nourah bint Abdulrahman University, P.O. BOX 84428, Riyadh 11671, Saudi Arabia halfassam@pnu.edu.sa

Table S1. Cost estimation details of the CaO prepared for eggshell

Material	Purchased quantity (g)	Total purchase cost (USD)	purchasing cost (USD/g)	Used quantity (g or mL)	cost of used quantity (USD)
eggshell waste	25	0	0	25	0
washing water	10	0.01	0.001	1	0.001
Equipment	Time (h)	Max. power (kW)	unit cost of power	Energy cost (USD)	
crushing	8	1	0.16	1.28	
Drying	10	1	0.16	1.6	
Calcination	2	1	0.16	0.32	
total				3.2	USD
yield				25	g
cost				0.13	USD/g

Table S2. Cost estimation details of the LDH

Material	Purchased quantity (g)	Total purchase cost (USD)	purchasing cost (USD/g)	Used quantity (g or mL)	cost of used quantity (USD)
Zinc salt	500	39.4	7.576	2	15.152
Ferric salt	500	55.81	2.4186	3	7.2558
NaOH	500	17.55	0.6	4	2.4
Equipment	Time (h)	Max. power (kW)	unit cost of power	Energy cost (USD)	
Hot plate	24	1	0.16	3.84	
dry	24	1	0.16	3.84	
centrifuge	0.5	1	0.16	0.08	
total				32.5	USD
yield				4	g
cost				8.14	USD/g

Table S3 Cost estimation details of the composite

Material	Purchased quantity (g)	Total purchase cost (USD)	purchasing cost (USD/g)	Used quantity (g or mL)	cost of used quantity (USD)
CaO support	1	0.12804	0.12804	2	0.25608
Zinc salt	500	39.4	7.576	2	15.152
Ferric salt	500	55.81	2.4186	3	7.2558
NaOH	500	17.55	0.6	4	2.4
Equipment	Time (h)	Max. power (kW)	unit cost of power	Energy cost (USD)	
Hot plate	24	1	0.16	3.84	
dry	24	1	0.16	3.84	
centrifuge	0.5	1	0.16	0.08	
total				32.8	USD
yield				6	g
cost				5.47	USD/g