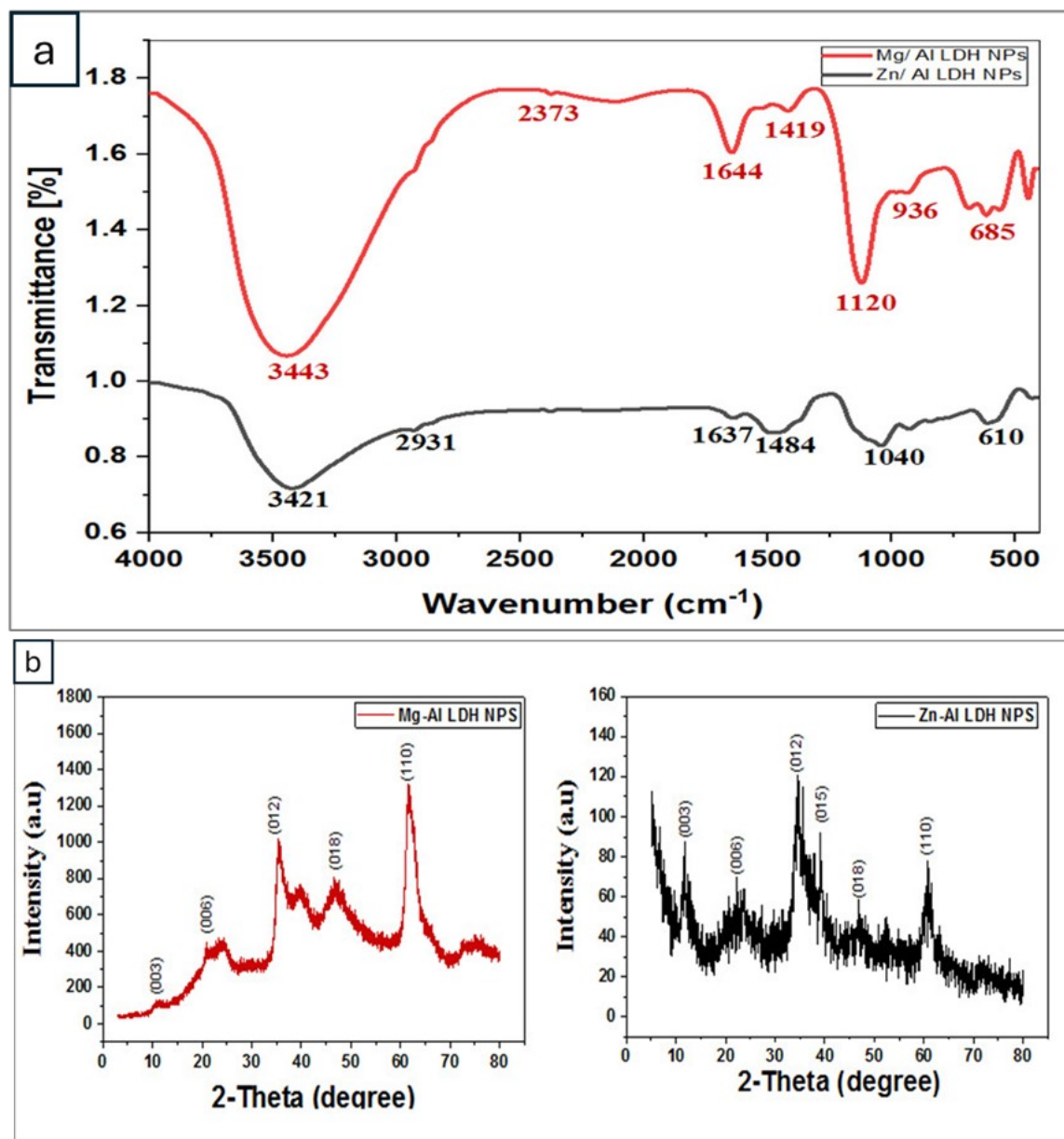
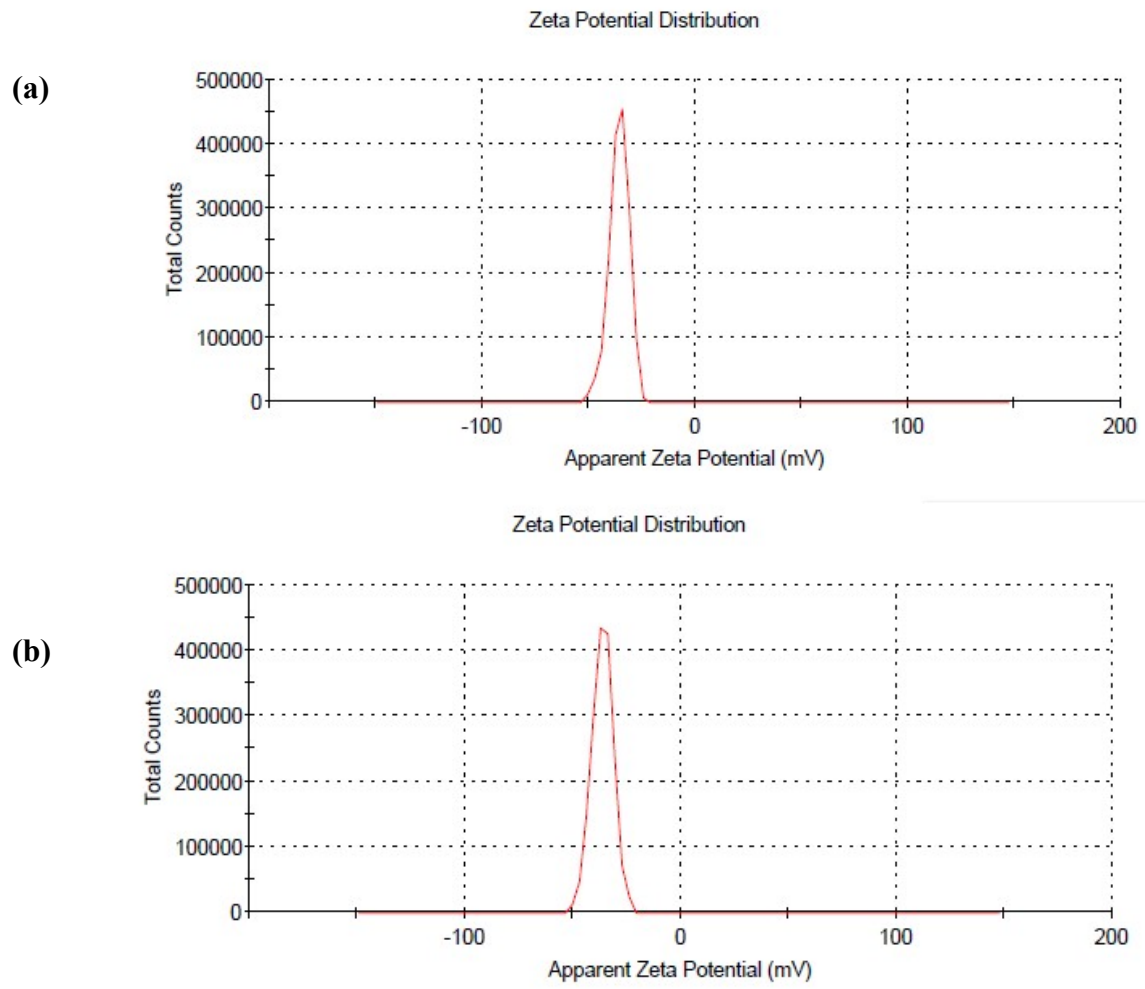


**Fig. S1** SEM image of synthesized Zn-Al LDH NPs and Mg-Al LDH NPs (a) Particle size at different average diameters of Zn-Al LDH NPs. (b) SEM shows the layer's shape on their surface aggregate of particles of Zn-Al LDH NPs. (c) SEM shows the aggregate nanoparticle on the layer's surface of Zn-Al LDH NPs. (d) the particle size at different average diameters of Mg-Al LDH NPs. (e) SEM shows nanoparticles appeared as aggregates resembling nearly spherical shapes of Mg-Al LDH NPs. (f) SEM shows the magnified aggregate nanoparticle of Mg-Al LDH NPs.



**Fig. S2** (a) FTIR chart of Zn-AL LDH NPs and Mg-AL LDH NPs and (b) XRD chart of Zn-AL LDH NPs and Mg-AL LDH NPs.



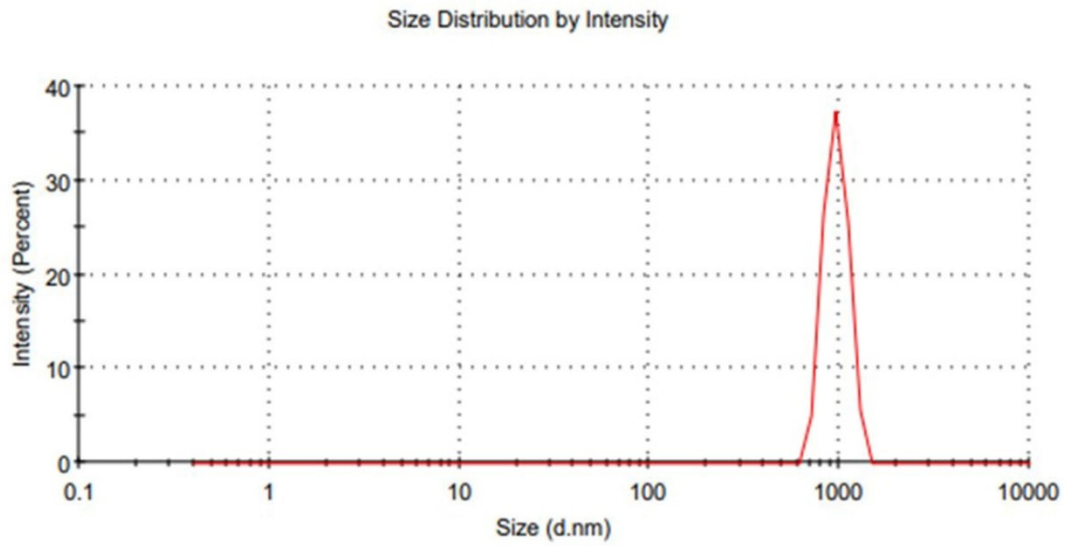
**Fig. S3** Zeta potential of (a) Zn-Al LDH NPs and (b) Mg-Al LDH NPs

(a)

	Size (d.nm):	% Intensity:	St Dev (d.n...)
<b>Z-Average (d.nm):</b> 892.7	<b>Peak 1:</b> 965.6	100.0	138.6
<b>Pdl:</b> 0.102	<b>Peak 2:</b> 0.000	0.0	0.000
<b>Intercept:</b> 0.919	<b>Peak 3:</b> 0.000	0.0	0.000

**Result quality :** Refer to quality report

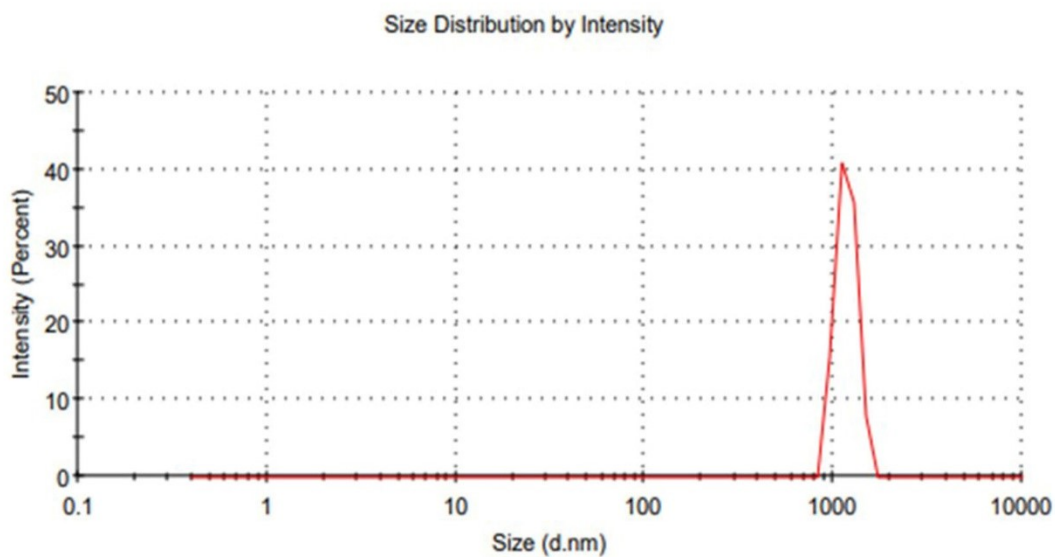
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(b)

	Size (d.nm):	% Intensity:	St Dev (d.n...)
<b>Z-Average (d.nm): 2903</b>	<b>Peak 1:</b> 1175	100.0	145.2
<b>Pdl: 0.602</b>	<b>Peak 2:</b> 0.000	0.0	0.000
<b>Intercept: 1.06</b>	<b>Peak 3:</b> 0.000	0.0	0.000

**Result quality : Refer to quality report**



**Fig. S4** Size distribution of (a) Zn-Al LDH NPs and (b) Mg-Al LDHNPs.

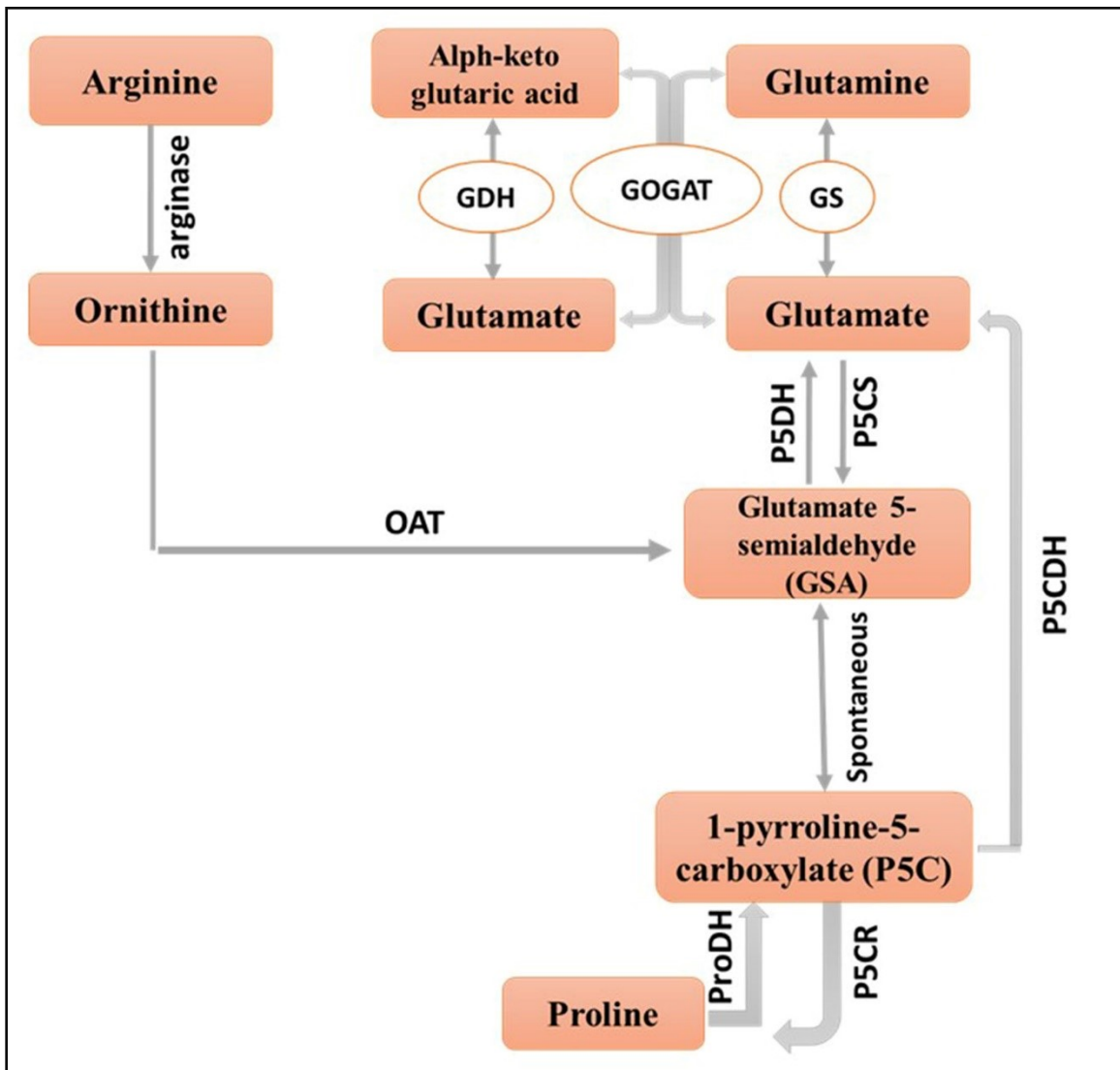
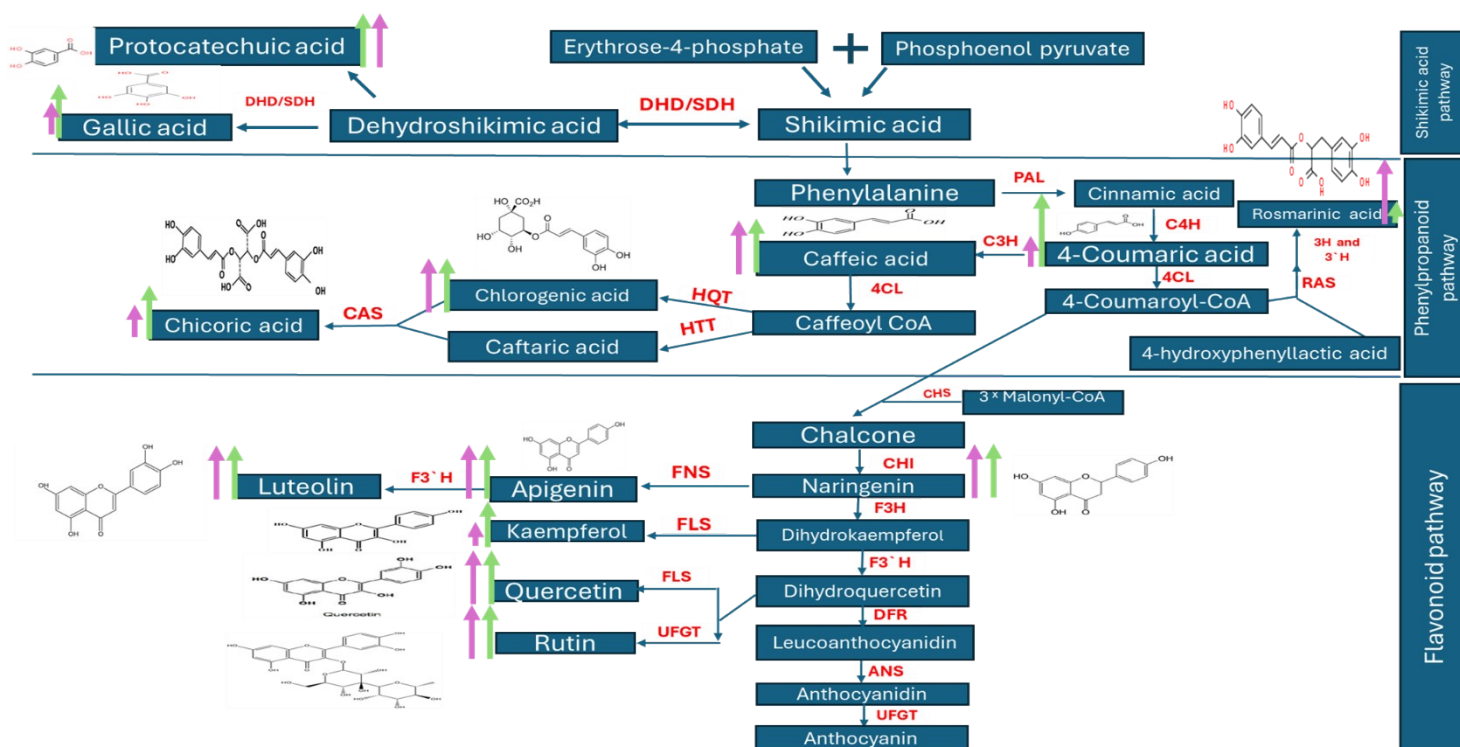




Fig. S5 The proline metabolic pathway



**Fig. S6** Biosynthesis pathway of phenolic compounds in geranium plant. Notes: Enzymes: DHD, 3-dehydroquinatase; SDH, shikimate dehydrogenase; PAL, phenylalanine ammonia lyase; C4H, cinnamate 4-hydroxylase; 4CL, 4-coumaroyl-CoA ligase; C3H, p-coumarate-3-hydroxylase; HTT, hydroxycinnamoyl-CoA: tartaric acid hydroxycinnamoyl transferase; HQT, hydroxycinnamoyl-CoA: quinate hydroxycinnamoyl transferase; CAS, chicoric acid synthase; 3H and 3'H, hydroxycinnamoyl-hydroxyphenyllactate 3- and 3'-hydroxylases; RAS: rosmarinic acid synthase; CHS, chalcone synthase; CHI, chalcone isomerase; F3H, flavanone 3-hydroxylase; F3'H, flavonoid 3'-hydroxylase; DFR, dihydroflavonol 4-reductase; ANS, anthocyanidin synthase; FNS, flavonol synthase; FLS, flavonol synthase; UFGT, flavonoid-3-O-glycosyltransferase.

 : Refers to Mg-Al LDH NPs and  : Refers to Zn-Al LDH NPs.