

Based on the research regarding "Metabolic Reprogramming in COVID-19" (MDPI, 2021) and related literature, several herbs and phytochemicals have been identified that target and potentially **reverse** the specific metabolic dysregulations (reprogramming) induced by the virus.

The virus reprograms the host's metabolism to favor **glycolysis** (sugar burning), **lipid accumulation** (for viral envelopes), and **amino acid depletion** (specifically tryptophan and arginine). The following herbs and compounds target these specific shifts:

## 1. Reversing Glucose Reprogramming (The "Warburg Effect")

The virus forces cells to switch to inefficient glycolysis (fermentation) even when oxygen is present, a state known as the Warburg effect, to rapidly generate energy for replication.<sup>1</sup>

- **Curcumin (from Turmeric):** Directly inhibits the glycolytic flux and downregulates the mTOR/HIF-1 $\alpha$  pathway, which is the "master switch" viruses use to turn on this metabolic reprogramming. [4.5]
- **Baicalin (from *Scutellaria baicalensis* / Chinese Skullcap):** A key component of the Lianhua Qingwen formula, it inhibits viral replication and modulates the metabolic burst associated with cytokine storms. [1.1, 4.4]
- **Andrographolide (from *Andrographis paniculata*):** Reduces blood glucose levels and prevents the virus from hijacking glucose for replication. It acts as a metabolic "brake" on the virus's energy supply. [2.2]

## 2. Correcting Amino Acid Depletion (Tryptophan & Arginine)

COVID-19 causes a "starvation" of Arginine (vital for T-cells) and Tryptophan (converting it into toxic Kynurene).<sup>2</sup>

- **Ginseng (*Panax ginseng*):** Restores immune homeostasis and has been shown to modulate the pathways related to arginine depletion, helping restore T-cell function that is typically "starved" during infection. [3.1]
- **Echinacea (*Echinacea purpurea*):** Modulates the non-specific immune response and can help counteract the arginine-depleting effects of the viral infection.<sup>3</sup> [3.1]
- **Ginger (*Zingiber officinale*):** Contains 6-gingerol, which regulates the balance of Th17/Treg cells. This regulation is critical because the tryptophan-kynurene shift is driven by hyper-inflammation (specifically IFN- $\gamma$ ), which ginger helps dampen. [1.1]

## 3. Modulating Lipid (Fat) Metabolism

The virus hijacks cholesterol and fatty acids to build its own membrane.

- **Licorice (*Glycyrrhiza glabra*):** Contains Glycyrrhizin, which targets the lipid-dependent entry mechanisms of the virus. It stabilizes cell membranes and prevents the virus from exploiting host lipids. [2.1]
- **Bitter Melon (*Momordica charantia*):**<sup>4</sup> Specifically targets lipid metabolism and has been shown to lower the "fuel" (glucose and lipids) available for viral replication, acting as a metabolic modulator. [2.2]

## 4. Comprehensive TCM Formulas

Traditional Chinese Medicine (TCM) formulas are designed to be "multi-target," addressing multiple metabolic errors simultaneously.

- **Lianhua Qingwen:** This formula (containing *Lonicera*, *Forsythia*, *Ephedra*, *Bitter Apricot*, *Gypsum*, etc.) has been proven to regulate the **mTOR** and **NF-\$\kappa\$B** signaling pathways. By doing so, it blocks the signal the virus uses to "order" the cell to reprogram its metabolism. [4.4, 4.5]
- **Jinhua Qinggan:** Composed of 12 herbs (including Honeysuckle and Mint), it targets the "Damp-Heat" toxin—which, in biomedical terms, correlates to the inflammatory cytokine storm that drives the metabolic shift. [3.6, 3.7]

### Summary Table of Metabolic Targets

Metabolic Shift	Corrective Herb/Compound	Mechanism
Hyper-Glycolysis	Curcumin, Baicalin	Inhibits mTOR/HIF-1\$\alpha\$ (the metabolic switch). [4.5]
Arginine Depletion	Ginseng, Echinacea	Restores T-cell energy and function. [3.1]
Tryptophan Drain	Ginger (6-gingerol)	Dampens the inflammatory drive (IFN-\$\gamma\$) causing the drain. [1.1]
Lipid Hijacking	Licorice, Bitter Melon	Stabilizes membranes; reduces lipid fuel availability. [2.1, 2.2]