

SCOPE OF *YASHTIMADHUKA (GLYCYRRHIZA GLABRA LINN)* IN CHILD UNDER NUTRITION - A REVIEW

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ABSTRACT

Under-nutrition in children, a major global health concern, shows dire consequences on their growth, development and immune system. Nearly half of all deaths in children under-five are caused due to under-nutrition globally. Hence, there is a need to explore broad-spectrum, nutritive and therapeutic herbs that can aid in the management of child under-nutrition. *Yashtimadhuka (Glycyrrhiza glabra Linn.)*, a widely used herbal drug in Ayurveda has rejuvenating, nourishing and strengthening properties according to Ayurveda's principles. It is easily available, economical, palatable and safe in recommended dose in children. It has a nutrient-rich and energy-dense composition. It also reports to have body weight gaining, haematinic, hepato-protective, antioxidant, immuno-stimulating, immuno-modulatory, neuro-protective, cerebro-protective, anti-inflammatory, antimicrobial, anti-allergic, anti-asthmatic and antitussive activities. Hence, the current review is compiled with information related to the therapeutic and nutritive potential of *Yashtimadhuka (Glycyrrhiza glabra Linn.)* in the management of under-nutrition in children from classical and modern perspective.

Key words: *Glycyrrhiza glabra Linn.*, *Yashtimadhuka*, *Karshya*, child under-nutrition

INTRODUCTION

Adequate nutrition in early childhood is indispensable for healthy physical growth and development, neurological and cognitive development and a strong immune system. Under-nutrition is a form of malnutrition that has two constituents namely protein-energy malnutrition and micronutrient deficiencies. Under-nutrition in children may lead to increased frequency &

severity of common infections, stunted physical growth and development and impaired cognitive ability thus, further leading to decrease in productivity and economic growth. It has been reported that under-nutrition is the cause of nearly half of all deaths in children under-five.^[1] Today, the modern management of under-nutrition in children focuses on provision of symptomatic

treatment along with energy-dense and nutrient-rich food supplements.

Under-nutrition in children may be correlated with the Ayurvedic description of symptoms explained under *karshya* or *krishangata* (emaciation) caused due to *apatarpana* (under-nutrition), vitiation of *Vata dosha* (humor) and also various disorders like *baalashosha*, *parigarbhika*, *mamsa parikshaya*, *meda kshaya*, *ksheeraja phakka* and *vyadhija phakka*. Ayurveda advocates pharmaco-therapies like *brimhana* or *laghu santarpana* (nourishment, weight promoting or strengthening and supplementation therapy), *deepana* (increasing digestive fire), *rasayana* (rejuvenation therapy) and *vrishya* (aphrodisiac therapy) in the management of *karshya* as they help to alleviate *vata dosha*, restore vitiated *agni* (digestive fire) and improve the quality and quantity of *rasa dhatu* and consecutive *dhatu*s (body tissues) thus leading to adequate growth and development. Hence, the holistic approach of Ayurveda in the management of under-nutrition includes not only provision of right nutrition but also restoration of the vitiated *agni* to improve the absorption and metabolism of ingested food, strengthening of the immune system and prevention of the disease with the help of many therapeutic and nutritive herbal drugs and formulations.

It is the need of the hour to look for such nutritive botanical therapeutics that are easily available, cost-effective, palatable, safe and effective in the management of under-nutrition in children. One such broad spectrum herb that is widely used in Ayurveda in pediatric formulations is *Yashtimadhuka* i.e *Glycyrrhiza glabra* Linn. belonging to the *Fabaceae* family that is known for its nutritious and medicinal family members. The word '*Glycyrrhiza*' has been de-

rived from the Greek word '*glykos*', meaning sweet and '*rhiza*', meaning root.^[2] *Glycyrrhiza glabra* L., commonly known as licorice, liquorice (sweet healer), *Mulethi*, *Jyeshthamadhya* or *Yashtimadhu* (sweet wood) is a perennial, glandular herb having sweet roots. It is one of the most important drugs used since the Vedic period. Detailed descriptions about the properties, pharmacological actions, uses and indications of *Yashtimadhuka* have been described in the Ayurvedic treatises namely *Charaka Samhita* (1000 B.C.), *Sushruta Samhita* (600 B.C.), *Vagbhata Samhita* (7th century A.D.) as well as in various *Nighantu* texts written between the 12th and the 14th centuries A.D. based on Ayurvedic literature. In Ayurveda, there are about 1250 formulations that contain *Yashtimadhuka* as one of its constituents.^[3]

Classification according to Ayurveda: (Table no. 1)

Parts used: Dried roots and stolons.^[4]

Phytochemistry:

The roots of *Glycyrrhiza glabra* Linn. chiefly contain an active principle glycyrrhizin (3.6%) which is a combination of glycyrrhetic acid and glucuronic acid. The other constituents include prenylated bioflavone, licoagron; 7- acetoxy- 2- methyl- isoflavone, 7- methoxy- 2- methylisoflavone and 7- hydroxy- 2 methyl isoflavone; 4- methyl coumarin, liquocoumarin; isoflavone, glyzaglabrin (7,2-dihydroxy 3,4-methylenedihydroxy isoflavone); quercetin, quercetin-3-glucoside, kaempferol, astragalol, liquiritigenin and isoliquiritigenin (root). Other constituents reported include a flavanone rhamnoglucoside, chalcone glucosides, trans- isoliquiritigenin- 4- -D-glucopyranoside (isoliquiritin) and trans- isoliquiritigenin- 4- -D-

glucopyranoside (neoisoliquiritin); 7-hydroxy-4-methoxyisoflavone (formetin), licuraside, liquiritoside, rhamnoliquiritin, triterpenoid, liquoric acid, 11-deoxyglycyrrhetic acid, liquiritic acid, isoglabrolide, glabrolide, deoxoglabrolide, glycyrrhizic acid, glycyrrhetol, 21-hydroxy-11-deoxyglycyrrhetic, and 24-hydroxyglycyrrhetic acids, 18-hydroxy glycyrrhetic acid, olean-12-en-3-ol-30-oic, olean-11, 13 (18)-dien-3-ol-30-oic acid, glabranine (5,7-dioxy-8-3 (3, 3-dimethylallyl)-flavanone), pinocembrin, prunetin, 4-hydroxy chalcone, liquiritigenin, licoflavonol (6,6-dimethylallylkaempferol), kumatakenin, glycerol, licoricone, glabridin, glabrol, liquirazid, liquiritin, 3-hydroxyglabrol, 4-O-methyl glabridin, 3-methoxyglabridin, glycyrrhetic acid; methyl olean-11,13 (18)-diene-3, 24-diol-30-oate, glabranine, formononetin, glabrene, saponaretin (isovitexin), 24-hydroxy-11-deoxyglycyrrhetic acid, methyl olean 11, 13 (18) diene-3, glycyrrhetol, 21-hydroxy isoglabrolide, licoflavonol, glyzarin, glyzaglabrin, licoisoflavones A, B and licoisoflavon, glycyrin, sugars and aspargin (root and other plant parts).^[5]

Nutrient composition:

The nutrient composition of *Glycyrrhiza glabra* L. reveals the presence of carbohydrates (in raw herb), proteins and fats (in raw herb, its tea and infusion dosage forms), micronutrients like calcium, phosphorous, sodium, potassium, iron, zinc and copper as well as amino acids namely aspartic acid, glutamic acid, threonine, serine, proline, glycine, alanine, valine, isoleucine, leucine, tyrosine, phenylalanine, histidine, lysine and arginine. (Table no.2 and Table no.3)

Pharmacological/ Biological activities:

i. Effect on weight, skin fold thickness, mid upper arm circumference, BMI

Glycyrrhiza glabra root extract at oral doses of 200, 400 and 800 mg/Kg for four weeks in male rats induced significant increase in body weight gain and feed efficiency ratio.^[7] A randomized controlled clinical trial on the efficacy of *Prinana Modaka* containing *Yashtimadhuka* as one of its contents in malnourished (Grade I and II) children of age group 5 to 12 years for 10 weeks reported increase in body weight, biceps skin fold thickness, triceps skin fold thickness, mid upper arm circumference (MUAC) and BMI by 5.56%, 9.59%, 4.69%, 8.57% and 2.20% respectively (Nirali Joshi 2011).^[8] Another comparative clinical trial on the efficacy of *Prinana Modaka* and *Balya* biscuit, both formulations containing *Yashtimadhuka* as one of their ingredients in malnourished (Grade I and II) children of age group 2 to 5 years for three months reported increase in body weight, biceps skin fold thickness, triceps skin fold thickness, MUAC and BMI by 5.30%, 30%, 26.67%, 4.47% and 2.95% respectively in the *Prinana Modaka* administered group whereas 6.73%, 22.33%, 18.69%, 4.11% and 4.25% respectively in the *Balya* biscuit administered group (Sandip Lad 2015).^[8]

ii. Effect on blood components

Licorice powder (*Glycyrrhiza glabra*) when supplemented with drinking water at two different doses (1.75 g/day and 3.5 g/day) for two months in female rabbits of age 3-4 months revealed that it could decrease serum lipid profile, increase serum total protein and its fractions (albumin and globulin) thus improving animal health.^[9] Glycyrrhizic acid can enhance the

total white blood cell (WBC) and red blood cell (RBC) counts (Raphael and Kuttan, 2003).^[6] Consumption of licorice tea can improve WBC and RBC counts and increase hemoglobin and blood platelets.^[6] A herbomineral formulation (HMF-TE) containing aqueous extract of *Glycyrrhiza glabra* as one of the ingredients, exhibited significant haematinic potential in haloperidol induced anemic rats by increasing parameters like haematocrit value, haemoglobin concentration, RBC count, MCV, MCH and MCHC.^[10]

iii. Effect on bioavailability

A patent invention of novel compositions containing extracts and compounds from the plant *Glycyrrhiza glabra* proved their usefulness as bioenhancers and bioavailability facilitators for drugs and molecules such as nutritional compounds.^[11]

iv. Hepatoprotective activity^[3,5]

The hepatoprotective effects of Glycyrrhizin due to its antilipid peroxidant, antioxidant, immunosuppressive and anti-inflammatory characteristics are proven. *Glycyrrhiza glabra* is a potential antioxidant and attenuates the hepatotoxic effect of CCl₄ by acting as an in vivo antioxidant and thereby inhibiting the initiation and promotion of lipid peroxidation or by an accelerated scavenging of free radicals and their products by conjugation with GSH aided by GST (MG Rajesh, *et al.*, 2004). Use of combination of Gly (Glycyrrhizin) and Mat (Matrine), a component extracted from *Sophora flavescens* Ait, protected liver function and prevented HCC from occurring (Xu-ying *et al.*, 2009). Aqueous extract of *G. glabra* showed significant effect in ameliorating liver functions as well as restoring hepatic tissue in acute liver diseases when it was

given in a single dose per day of 2g/kg body weight. The aqueous extract of *G. glabra* roots can be used for prevention and treatment of liver disorders. *G. glabra* is proven for its best antioxidant potential and liver protective effects like standard drug – Silymarin.

v. Regulation of gastrointestinal motility^[3]

Isoliquiritigenin plays a dual role in regulating gastrointestinal (GI) motility, both spasmogenic and spasmolytic and restores GI health.

vi. Antioxidant activity^[3]

Hispaglabridin B, isoliquiritigenin, and paratocarpin B were found to be the most potent anti-oxidant agents. Administration of *Glycyrrhiza glabra* root powder (5 and 10 gm% in diet) to hypercholesterolemic rats resulted in significant reduction in plasma, hepatic total lipids, cholesterol, triglycerides, plasma low-density lipoprotein and VLDL-cholesterol accompanied by significant increases in HDL cholesterol levels and improvement in the antioxidant status (Visavadiya NP, *et al.*, 2006).

vii. Immunostimulating and immunomodulatory activity^[3,12]

The Immuno-stimulating complexes formulated with saponins from plants (*Aesculus hippocastanum* and *Glycyrrhiza glabra*) were an effective antigen delivery system which may be successfully used, with low toxicity, for preparation of highly immunogenic coccidian vaccine (Berezin VE, *et al.*, 2008). Licorice enhanced the macrophage membrane function. 20µg/mL of licorice proved the co-mitogenic potential for both T and B avian lymphocytes (Dorhoi A, *et al.*, 2006). Licorice has been widely used in immuno-modulating formulations.

viii. Neuro-protective activity^[3]

Glabridin showed a neuro-protective effect via modulation of multiple pathways associated with apoptosis (Yu XQ, *et al.*, 2008).

ix. Effect on learning and memory^[3,5,12,13]

Yashtimadhu is effective in the improvement of neuro pharmacological activity (*medha*: intelligence, memory) in adolescents. *Glycyrrhiza glabra* gave promising results as a memory enhancer in both exteroceptive and interoceptive behavioral models of memory (Parle M, *et al.*, 2004). The aqueous extract of liquorice (150 mg/kg) significantly improved learning and memory of mice. Glabridin prevented the deleterious effects of diabetes on learning and memory in rats due to its combination of antioxidant, neuroprotective and anticholinesterase properties (Hasanein P., 2011).

x. Resistance to vibration, stress^[3,5,14]

Biological active substances of licorice accelerate metabolism processes of the marrow stem cells, enlarge organism compensatory abilities, in that way providing organism resistance to vibration (Minasian SM, *et al.*, 2007). Active substances of licorice root accelerated metabolism in cells of the bone marrow erythroid stem, enhanced compensatory reserve of the organism and increased animal's resistance to stress (Adamyan TL, *et al.*, 2005). *Glycyrrhiza glabra* was effective in reversing chronic fatigue induced memory dysfunction, immobility, hyperalgesia, anxiety and muscle inco-ordination in mice.

xi. Anti-depressant activity^[3]

Antidepressant-like effect of liquorice extract seems to be mediated by increase of brain norepinephrine and dopamine, but not by

increase of serotonin (Dhingra D. *et al.*, 2006b). *Glycyrrhiza glabra* has a good potential as an adjuvant of anti-Parkinsonian and antidepressant drugs (SB Kasture *et al.*, 2008).

xii. Anxiolytic activity^[3]

Hydroalcoholic extract of roots and rhizomes of *Glycyrrhiza glabra* exhibited anxiolytic activity.

xiii. Anti-allergic^[3]

Anti-allergic effects of licorice were mainly due to glycyrrhizin, 18 -glycyrrhetic acid, and liquiritigenin, which could relieve IgE-induced allergic diseases such as dermatitis and asthma (Shin YW, 2007).

xiv. Anti-viral activity^[3]

In-vivo studies of the plant demonstrated a reduction of mortality and viral activity in herpes simplex virus encephalitis and influenza A virus pneumonia. In vitro studies revealed antiviral activity against HIV-1, SARS related coronavirus, respiratory syncytial virus, arboviruses, vaccinia virus and vesicular stomatitis virus (Fiore C, *et al.*, 2008). Glycyrrhizin's prominent antiviral activity is due to the fact that it does not allow the viral cell binding. - Glycyrrhizic acid has been found to inhibit HIV-1 reproduction in MT-4 cells. Glycyrrhizin was the most effective in controlling viral replication of SARS virus.

xv. Anti-bacterial activity^[3,12]

Through the improved production of antimicrobial peptides in tissues surrounding the burn area, sepsis stemming from *P. aeruginosa*, wound infection is controllable by glycyrrhizin in severely burned mice (Tsuyoshi Yoshida, 2010). Glicophenone and glicosoflavanone

present in *G. glabra* have demonstrated potential activity to control Methicillin resistant *S. aureus*.

xvi. Anti-inflammatory activity^[3]

Prevention of the activation of NF-kappaB and STAT-3 by glycyrrhizin at 10 mg/kg i.p. 5 minutes prior to carrageenan in mice model reduced the development of acute inflammation (Menegazzi M, *et al.*, 2008). Rectally administered glycyrrhizic acid had significant protective effects against TNBS-induced colitis in rats, and the rectal route could be a complementary treatment for inflammatory bowel disease (Liu Y, *et al.*, 2011).

xvii. Anti-diabetic activity^[12]

Ethyl acetate extract of licorice using GAL-4-PPAR- chimera assay, displayed a significant PPAR- binding activity due to six phenolic compounds namely dehydroglyasperin, gluasperin B, gluasperin D, glycy coumarin, glycyrin, glycol, and isoglycol. Glycyrrhizin has also shown anti-diabetic activity in non-insulin dependent diabetic model.

xviii. Anti-asthmatic activity^[3]

Glycyrrhizin alleviated asthmatic features in mice and it could be useful towards developing a better therapeutic molecule in the future (Ram A, *et al.*, 2006). Saponins and flavanoids were the major reason for antioxidant activity as confirmed by DPPH free radical scavenging activity test and were responsible for treating oxidative stress during asthma (Tulsiani Puja, 2012).

xix. Antitussive and demulcent activity^[12]

The licorice powder and extract exhibit antitussive and expectorant action. The demulcent action is due to glycyrrhizin. Liquiritin

shows inhibitory action on capsaicin-induced cough.

xx. Hair growth promoting activity^[5]

As per in-vivo study, animals treated with petroleum ether extract of *G. glabra* roots showed longer hair than those treated with either minoxidil or control.

Ayurvedic properties^[5,15,16]:

- **Rasa (taste)** - *Madhur* (sweet)
- **Veerya (potency)** - *Sheeta* (cold)
- **Vipaaka (metabolic property)** – *Madhur* (sweet)
- **Guna (quality)** - *Guru* (heavy), *Snigdha* (oily)
- **Doshaghnata (action on body humors)** - *Vatapitta-shamaka* (alleviation of Vata and Pitta)
- **Sthanika Karma (local action)** – *Dahashamaka* (alleviates burning sensation), *Keshya* (promotes hair growth), *Vedanasthapana* (alleviates pain), *Shothahara* (reduces inflammation)
- **Abhyantar karma (internal pharmacological action)** – *Balya* (promotes physical strength), *Brimhana* (nutritious), *Chakshushya* (improves vision), *Vrishya* (aphrodisiac), *Jeevaneeya* (promotes healthy life), *Sandhaneeya* (reconstructive), *Rasayana* (rejuvenator), *Varanya* (improves complexion), *Keshya* (promotes hair growth), *Swarya* (improves voice), *Ruchya* (enhances taste), *Raktaprasadana* (improves blood quality), *Vishaghna* (antitoxic), *Mutral* (diuretic), *Mutravirajaneeya* (imparts colour to urine), *Shoshahara* (cures cachexia), *Kshayahara* (cures pthisis), *Chardihara* (cures emesis), *Vranahara* (heals wound), *Shothahara* (reduces edema), *Trishnahara* (cures thirst), *Glaanihara* (cures exhaustion),

Kasaghna (cures cough), *Shwasaghna* (cures asthma), *Shirashoolahara* (cures headache), *Netrarogahara* (cures ophthalmic disorders), *Kandughna* (cures itching), *Jwarashamak* (antipyretic).

Dosage: 2 to 4 gm of the drug in powder form.^[16]

Safety aspect:

The drug used in traditionally prescribed doses may be considered safe.^[16] The United States Food and Drug Administration believes that foods containing liquorice and its derivatives (including glycyrrhizin) is safe if not consumed excessively. Other jurisdictions have suggested about 100mg to 200mg of glycyrrhizin per day, the equivalent of about 70g to 150g of liquorice as safe.^[17]

Toxicity:

Excessive consumption of licorice in both forms (tea and infusion) can lead to the classic symptoms of hypertension due to increase in the absorption of sodium and water in kidneys (Miettinen et al., 2010).^[6] It may also cause pseudoaldosteronism and hyperkalemia.^[12] LD₅₀ of glycyrrhizin-thiamine HCL in rats is reported to be 1.94 g/kg and 0.764 g/kg s.c. respectively. Liquiritoside a root flavonoid is a low toxic substance. Consumption of liquorice (10-45 g/day) is reported to cause raised blood pressure, together with a block of aldosterone/ rennin axis and electrocardiogram changes.^[5]

Adulterants:^[5]

Liquorice root is often adulterated with root of *Glycyrrhiza uralensis* Fisch. (Manchu-

rian liquorice), root of *Abrus precatorius* Linn. or stem pieces of *Glycyrrhiza glabra*.

Uses:

Glycyrrhiza glabra is indicated in peptic ulcers, gastritis, dyspepsia, dermatitis, allergies, viral infections, respiratory tract infection, chronic stress, chronic fatigue syndrome, complications of diabetes, weight loss and Addison's disease.^[18] It stops diarrhoea and relieves fatigue, lack of appetite and gastric irritation.^[19] *Glycyrrhiza glabra* L. is listed among common medicinal plants that possess nutraceutical potential.^[20] As an adaptogen, licorice benefits the HPA axis function and the sympathoadrenal system^[19] and can help in restoring the functions of the thyroid and/or the adrenals. Adaptogens help to regulate the neuroendocrinal and immune systems, provide a defense against stress and maintain optimal homeostasis.^[19] They work as tonics or *rasayana dravyas* (Ayurvedic rejuvenative medicines) that have a long history of safety and efficacy.^[19]

Important nutritive and therapeutic formulations containing Yashtimadhuka for children:

The critical role of adequate nutrition right from pre-conception, then pregnancy, infancy and childhood to prevent nutritional disorders in children has been well emphasized by Ayurveda. *Yashtimadhuka* is a major ingredient in the *masanumasika kashayas* (monthly herbal decoctions) prescribed in the first, fourth, seventh, ninth and tenth month of pregnancy for the well-being and nutrition of the pregnant mother and the fetus^[21]. During infancy and childhood, *Acharya* Charaka has advised the use of *yashtimadhuka churna* (powder) with milk as *medhya rasayana* (promoter of intelli-

gence/memory).^[22] Acharya Sushruta has also mentioned the use of *Yashtyadi ghrita* (medicated ghee) for promoting physical growth and intelligence in children.^[23] Acharya Vagbhata has advised various therapeutic and nutritive formulations that contain *Yashtimadhuka* for children namely *Preenana modaka*, *Vakshuddhi avaleha*, *Shoshajit ghrita*, *Shringyadi ghrita* and *Sarvarogahara ghrita* internally and *Lakshadi taila* for external application.^[21] Internal use of formulations of *ghrita* (ghee), *taila* (oil), *milk and yoosha* (soups) fortified with *Yashtimadhuka*, described as *sarvarogaghna* (curer of all diseases), are mentioned in the *Kashyap Samhita* for the nourishment of children.^[24]

Traditionally, in anaemia, a decoction or powder of *yashtimadhuka* with honey and in edema, a paste of licorice, *Sesamum indicum*, milk with butter have been prescribed.^[25] *Yashtimadhuka* is used as an energy tonic, particularly for the spleen and stomach and in the treatment of diarrhoea and fevers.^[25] *Yashtimadhuka* forms a part of *Ura-marunnu*, a traditional baby care practice comprising a paste of group of drugs administered to child from day one of birth in southern part of India as a preventive and curative aid for digestive disorders and to promote overall well being.^[26] In Chinese medicine, it is considered as a very significant herb and is recommended as a tonic, anabolic and expectorant medicine.^[27] For fatigue, *mulethi* mixed with lukewarm milk is prescribed to strengthen the body and produce a new spirit of enthusiasm.^[27] In cases of indigestion and constipation in babies, *mulethi* yields very good results when it is combined with other herbs.^[27] *Yashtimadhuka* was used as one of the contents in the development of a novel Ayurvedic formulation of *Paushtika* biscuit indicated as a food of

choice in weaning period for the treatment of malnutrition in children.^[28] The clinical study on the effect of *Madhwashwayoga* (*Kalpita yoga* containing *Ashwagandha*, *Sunthi* and *Yashtimadhu*) on *Balashosha* with reference to malnutrition revealed that *Madhwashwayoga* accelerates growth, development and immunity of growing child as it showed very significant results in development and nutrition in children.^[29]

DISCUSSION

Considering the usefulness and demand of research on broad-spectrum herbal drugs for management of under-nutrition in children, *Yashtimadhuka* was reviewed for its specific therapeutic and nutritive potential. *Yashtimadhuka* has dominance of *prithvi* (earth) and *aapa* (water) *mahabhootas* (macroelements), *madhura rasa*, *sheeta veerya*, *madhura vipaaka* and *guru,snigdha* properties. Due to its *vata-pitta shamaka*, *brimhaneeya*, *balya*, *vrishya*, *chakshusya*, *keshya*, *ruchya*, *medhya*, *varnya*, *shothanashaka*, *shoshanashaka* and *kshayahara* pharmacological actions, it may help in prevention and *samprapti vighatana* (breaking of pathogenesis) of *karshya* according to Ayurveda's principles. Hence, it has been used as an important ingredient in many nutritive and therapeutic formulations for nourishment of children in Ayurveda.

The previous research works on *Glycyrrhiza glabra* L. have proven its body weight gaining, haematinic, bioenhancing and bio-availability facilitating, hepato-protective, GI motility regulating, anti-oxidant, immunomodulatory, immuno-stimulating, neuro-protective, cognitive, anti-bacterial, anti-viral, anxiolytic, anti-inflammatory, anti-asthmatic,

antitussive and hair growth promoting activities due to its varied phytoconstituents which may aid in treating symptoms and associated complications of undernutrition like weight loss, gastroenteritis, anemia, edema, lethargy, skin and hair changes, loss of appetite, fever, cough, cold, breathlessness, convulsions, eye disorders, fatty liver, defective immunity, reduced IQ, muscle weakness, URTI, bacterial and viral infections and parasitic infestations in children. It also shows the presence of carbohydrates, proteins and fats that may provide energy promote growth and development and regulate body functions. The presence of minerals like calcium, sodium, phosphorus, potassium, iron, zinc and copper and essential and non essential amino acids in the herb may have a beneficial effect on linear growth, cognitive development and overall health in children. In-vivo and clinical studies on the herb and its phyto-constituents have also reported increase in weight gain, biceps and triceps skin fold thickness, MUAC, BMI, serum total proteins, albumin, globulin, hemoglobin and blood platelets and improvement in WBC and RBC counts on its administration.

CONCLUSION

Research on the role of herbs in disease prevention and management has gained focus. *Yashtimadhuka* may provide balanced nutrition, promote physical, neurological and cognitive health as well as strengthen immune system of children due to its nutritive, energy boosting, digestive, cognitive, memory enhancing and immuno-modulatory properties. Due to its multifaceted actions, it may serve as a natural, cost-effective, palatable, safe, preventive as well as curative alternative like a monotherapy or an adjunct with conventional agents or a supportive

therapy in the management of under-nutrition and associated disorders in children. Lipid based formulations such as *ksheerpaka* (medicated milk infusion), *siddha ghruta* (medicated cow ghee) and ready-to-use therapeutic foods that are fortified with *Yashtimadhuka* may be used in the management of mild to moderate undernutrition and also in micronutrient deficiencies. The Ayurvedic texts as well as modern pharmacological, experimental and clinical studies are supportive of the significant therapeutic and nutritive potential of *Yashtimadhuka*. Hence, the plant may serve as a vital constituent for the development of novel agents in the management of under-nutrition in children in the upcoming years. There is a need for added clinical evaluation of the herb in child under-nutrition in larger samples.

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Table 1: Classification of *Yashtimadhuka* in Ayurvedic texts

Name of Samhita/Nighantu	<i>Gana / Varga</i> (Class)
<i>Charaka Samhita</i>	<i>Jeevaniya gana, Varnya gana, Kandughna Gana, Shonitasthapana gana</i>
<i>Sushrut Samhita</i>	<i>Sarivadi gana, Anjanadi gana, Kakolyadi gana</i>
<i>Vagbhata Samhita</i>	<i>Sarivadi gana, Anjanadi gana</i>
<i>Dhanvantari Nighantu</i>	<i>Guduchyadi varga</i>
<i>Bhavaprakash Nighantu</i>	<i>Haritakyadi varga</i>
<i>Raj Nighantu</i>	<i>Pippalyadi varga</i>
<i>Madanpal Nighantu</i>	<i>Abhayadi varga</i>
<i>Shaligram Nighantu</i>	<i>Ashta varga</i>
<i>Shodhala Nighantu</i>	<i>Guduchyadi varga</i>
<i>Nighantu Adarsha</i>	<i>Palashadi varga</i>
<i>Kaiyyadev Nighantu</i>	<i>Oushadhi varga</i>
<i>Priya Nighantu</i>	<i>Shatapushpadi varga</i>
<i>Dravyaguna Vidnyan</i>	<i>Chedanadi varga</i>

Table 2: Nutritional composition of raw herb, tea form and infusion form of *Glycyrrhiza glabra* L. [6]

Macronutrients (%)	Raw herb	Tea form	Infusion form
Carbohydrate	47.11	-	-
Protein	9.15	1.55	1.81
Fat	0.53	free	Free
Micronutrients	(mg/100 g)	(mg/100 ml)	(mg/100 ml)
Calcium (Ca)	1720	30	80
Phosphorous (P)	78	1	4
Micronutrients	(ppm)	(ppm)	(ppm)
Sodium (Na)	18580	455.2	550
Potassium (K)	7276	178.4	215.1
Iron (Fe)	1224	4.189	2.28
Zinc (Zn)	17.08	0.188	L
Copper (Cu)	11.01	0.076	L

(ppm: parts per million)

Table 3: Amino acid composition of raw herb, tea form and infusion form of *Glycyrrhiza glabra* L. [6]

Amino acids	Raw herb (%)	Tea form (mg/100ml)	Infusion form (mg/100ml)
Aspartic	0.88	4.87	4.17
Glutamic	0.50	2.06	2.87
Threonine	0.32	1.20	1.54
Serine	0.41	1.44	1.81
Proline	1.02	7.60	6.80
Glycine	0.25	1.18	1.56
Alanine	0.51	0.86	1.34
Valine	0.44	2.55	3.47
Isoleucine	0.21	0.55	0.92
Leucine	0.38	1.24	2.04
Tyrosine	0.31	-	1.55
Phenylalanine	0.33	-	-
Histidine	0.22	0.71	0.84
Lysine	0.36	1.49	1.53
Arginine	0.30	1.14	0.93

Source of Support: Nil

Conflict Of Interest: None Declared

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