Bioactive Components and Pharmacological Properties of Edible Bird’s Nest

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Abstract. Edible bird’s nest (EBN) refers to animal product, namely solidified saliva from edible bird’s nest swiftlet species in the genus of Aerodramus fuciphagus and Collocalia sumbawae. The shallow cup shaped of the nests are composed of interwoven strands of salivary cement, constructed by the male swiftlet on the upper part of the cave walls over a period of 35 days during the breeding season. The EBN has been used for centuries among Chinese communities. However, the hefty price of the EBN only allows the privilege groups to afford it. Long term EBN consumers claimed that they do see or feel the health benefits given by the EBN although many people have doubt with the health benefits of EBN for centuries. In fact, the health benefits of the EBN lies in the bioactive components and nutrition values of the EBN. In order to clarify the exact health benefits contributed by EBN, the bioactive components in EBN that exhibit the bioactive and pharmacological activities were reviewed with the scientific proofs and clinical studies. The sialic acid comprises of 9 - 12% in EBN, which possesses health benefits such as healthy nerve and brain function, immune-enhancing activity, memory enhancement. Other bioactive components such as epidermal growth factor (EGF), N-acetylgalactosamine (galNAc), N-acetylglucosamine (glcNAc), galactose and fucose which exhibit the neurotrophic activity, cartilage regeneration, anti-arthritis, healthy brain development and anti-microbial activity were reviewed in detail here. Nutritional values such as mineral compositions, amino acid content and the polysaccharides components in relation to human nutrition and health were highlighted here.

Keywords: edible bird’s nest, sialic acid, pharmacological properties

1. Introduction

Edible bird’s nest (EBN) is made of salivary secretions by swiftlet species in the genus of Aerodramus fuciphagus and Collocalia sumbawae. The natural edible bird’s nest is originally obtained from the limestone caves in tropical jungles, sea sides and coastlines, comprising the regions of Southeast Asian countries such as Thailand, Indonesia, Malaysia, Vietnam and the Philippines [1]. The EBN can be found in the limestone caves around the Indian Ocean, North Australia and the Pacific Islands. Due to the increasing of market demand for the EBN in China, the overharvesting of the cave EBN has led to setting up of EBN in many countries of Southeast Asia [2]. In fact, the majority of the EBN these days are being farmed. The cave EBN is still available in the market with limited amount and higher price compared to farmed EBN.

Although the EBN price has been sky-rocketing over the years, this does not reduce the market demand of the EBN. The price of EBN has been reported to be US$ 2170 per kilogram with its total export value of approximately US$ 4.2 million a year [3]. Peoples in China and Southeast Asia have been consuming EBN for many centuries. They believe in the health benefits from consuming the EBN such as complexion, vitality and health improving effects. Some people do not believe in the health benefits given by EBN. After all, they believe that the nutrients in the EBN can be sourced from other cheaper food. The debate of the
health benefits of EBN has undeniably been going on for many years. The review here was focussed on the scientific and clinical researches that have been done on EBN in the aspects of bioactive compounds and pharmaceutical properties in order to clearly justify the fact of the health benefits given by the EBN to consumers.

2. Nutritional Values and Bioactive Compounds of Edible Bird Nest

The major content of edible bird nest is glycoprotein. It has been reported that the average crude protein content in the edible bird nest glycoprotein are in the range of 50 – 65 % [4, 5]. Protein is the major nutrient that is important for metabolic functions, body tissues repairing and regeneration. Marcone (2005) reported the carbohydrate content of the edible bird nest to be 27.26%. According to Kathan and Weeks (1969), the carbohydrate component in edible bird nest consists of 9% sialic acid, 7.2% galactosamine, 5.3% glucosamine, 16.9% galactose, and 0.7% fructose [6].

Sialic acid is the main bioactive compound associated to EBN [7]. Many studies have reported the pharmacological effects of sialic acid to human health [8, 9]. Sialic acid is the N- or O-substituted derivatives of neuraminic acid, a monosaccharide with a nine-carbon backbone that is also known as N-acetylneuraminic acid (Neu5Ac or NANA). Sialic acids are widely distributed in animal tissues and to a lesser level in other organisms, ranging from plants and fungi to yeasts and bacteria, mostly in glycoproteins and gangliosides.

The other major glyconutrients namely N-acetylgalactosamine (galNAc), N-acetylglucosamine (glcNAc), galactose and fucose were reported to be found in carbohydrate components of EBN [9]. GalNAc is important for the function of the synapses, which is the junction between nerve cells; while the deficiency of GalNAc can lead to memory loss [10]. It can be postulated that GalNAc may improve the conditions of the Alzheimer’s patients. GlcNAc is an amino acid and a prominent precursor for glycosaminoglycan, which is a major component of joint cartilage. It has been reported that the consumption of EBN is similar to supplemental glucosamine in preventing cartilage deterioration and in relieving the symptoms associated with arthritis [11]. Galactose and fucose are vital for brain development, cellular communications and they possess antibacterial properties.

There are 18 types of amino acids, which include the eight essential amino acids, namely phenylalanine, valine, threonine, tryptophan, isoleucine, methionine, lysine and leucine. EBN offers all the amino acids that are necessary for human body especially the cells growth and regeneration. This is why edible bird nest soup has been always consumed by different age groups including patients after surgery and women during pregnancy or after delivering baby. Essential amino acids, namely lysine and tryptophan are not usually originated from plant proteins. Several studies have reported that aspartic acid and serine are the major amino acids found in EBN [10, 11]. The water-soluble aspartic acid and serine possess the skin healing property, which is vital for the cell’s energy production, cell function regulation and immune system generation by synthesizing immuno-globulins and antibodies.

It has been reported that farmed EBN contains minerals such as sodium (650 ppm), potassium (110 ppm), calcium (1298 ppm), magnesium (330 ppm), phosphorous (40 ppm) and iron (30 ppm) [5], in which sodium, magnesium and potassium and calcium are the major minerals content in EBN. These minerals are essential to human body as they are vital for the activation of many enzyme reactions in human body. For example, sodium balances the electrolyte, body fluid volume; maintain the nerve impulse condition while magnesium maintains the alkaline balance and control of the neuromuscular activity.

3. Pharmacological Activities of Edible Bird’s Nest

3.1. Antioxidants

Edible bird nest has been reported to possess antioxidant property [12] that is beneficial in cardiometabolic disease [13]. The prevalence of cardiometabolic disease is increasing over the users and women after menopause have a higher risk of developing metabolic disease [14]. Hou et al. (2015) evaluated the nutrigenomic effect of edible bird nest on ovariectomised female rats [13]. The female rats were fed with edible bird nest for 12 weeks and metabolic markers were measured at the end of the experiment. The authors reported that edible bird nest significantly improved the levels of superoxide dismutase (SOD),
insulin, estrogen, malondialdehyde, lipid profile and oral glucose tolerance test [13]. Also, edible bird nest produced transcriptional regulation of hepatic insulin signalling genes that enhanced homeostasis of lipid and glucose as well as insulin sensitivity [13]. Therefore, the authors [13] suggested that edible bird nest might possess the potential to meliorate estrogen deficiency-associated risk of cardiometabolic disease.

An in vitro study by Yida et al. (2014) reported that the digested water extracts for edible bird nest sample significantly improved the antioxidant activity based on antioxidant assays which were 2,2’-azino-bis (ABTS) and oxygen radical absorbance capacity (ORAC) [12]. The authors also reported that cell viability for edible bird nest extract was >80% at 1000 μg/mL and no toxic effects was reported on HEPG2 cells when acridine orange/propidium iodide (AOPI) staining was used [12].

EBN extract has a relatively high antioxidant capacity under hydrolysis process. The antioxidant activities in the edible bird nest extract may be due to the amino acids present in the edible bird nest after hydrolysis. For example, cysteine, methionine, histidine, tryptophan and lysine are the amino acids that have been proven for their antioxidant activities. This can be concluded the antioxidant activities of EBN will be obtained by our body after gastrointestinal digestion, which is responsible for health benefits such as anti-aging, anti-cancer and radical scavenging activity.

3.2. Cell proliferation effect

Edible bird nest also possesses the ability to potentiate mitogenic responses. For example, Roh et al. (2012) evaluated the effect of edible bird nest on the proliferation of human adipose-derived stem cells [15]. The authors reported that edible bird nest significantly promoted the proliferation of stem cells. In addition, the expression of interleukin (IL)-6 and vascular endothelial growth factor (VEGF) genes were induced by edible bird nest. Therefore, the authors suggested that the induced proliferation effect shown by edible bird nest might occur through the expression of IL-6 and VEGF genes medicated by NF-κB and activator protein (AP)-1.

Similarly, Rashed and Nazaimoon (2010) investigated the effect of edible bird nest on the proliferation and viability of Caco-2 cells using 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide (MTT) assay [16]. The cells were exposed to edible bird nest for 24 hours at a concentration of 5 ppm [16]. The percentage of cell proliferation when the cells were treated with edible bird nest ranged from 47 to 115% [16]. Although the authors suggested that edible bird nest might possess cell proliferation effect and growth-stimulating component, the types and sources of edible bird nest might play an important role [16, 17].

In a study investigating the effect of edible bird nest on corneal keratocytes from New Zealand White Rabbits, Zainal Abidin et al. (2011) reported that the highest cell proliferation was found when 0.05% and 0.1% of edible bird nests were used [17]. The authors suggested that when low concentration of edible bird nest is used, it could be used to synergistically induce cell proliferation and functional maintenance, especially for healing corneal wounds [17].

3.3. Anti-inflammatory effect

One of the health benefit claims of edible bird nest is the anti-inflammatory effect. An increase level of tumour necrosis factor-alpha (TNF-α) has been associated with diabetes, inflammatory bowel disease and rheumatoid arthritis. Rashed and Wan Nazaimoon (2010) investigated the proliferative effect of edible bird nest on human colonic adenocarcinoma cell line (Caco-2 cells) and macrophage cell line [16]. The authors reported that edible bird nest significantly reduced the production of TNF-α to 24% [16].

3.4. Anti-viral

Edible bird nest has been traditionally used for treating respiratory diseases including cough and flu. Guo et al. (2006) reported that edible bird nest extract hydrolysed with a pancreatic enzyme (Pancreatin F) significantly inhibited influenza virus infection in a host range-independent relationship. In addition, the extract neutralised Madin-Darby canine kidney (MDCK) cells infected influenza virus and inhibited the hemagglutination of influenza virus to erythrocytes [18]. The authors suggested that edible bird nest might be used as a natural source to prevent influenza virus infection. This is because of the presence of the sialic acid in edible bird nest.
Another study by Haghani et al. (2016) reported that edible bird nest had high neuraminidase inhibitory property which had the same effectiveness as Oseltamivir Phosphate (Tamiflu) [19]. The authors also showed that edible bird nest significantly increase the levels of NF-κB, IL-2, TNF-α, IL-6, IL-10, IL-12 and IL-27 [19]. In addition, a higher antiviral activity was associated with a higher content of acetylated sialic acid found in edible bird nest. Therefore, the author suggested that edible bird nest can be used to inhibit influenza virus type A [19].

Similarly, Vimala et al. (2012) also investigated the effect of white edible acid hydrolysate on the generation of TNF-α and nitric oxide (NO) [20]. The authors reported that edible bird nest inhibited the production of TNF-α and NO by 58% and 63%, respectively, without any significant cytotoxic effect to the cell line. In a study investigating the effect of edible bird nest on high fat diet-induced insulin resistance in rats, Yida et al. (2015) reported that edible bird nest significantly lower the levels of insulin, total cholesterol and leptin [8]. Therefore, it is suggested that the prevention of high fat diet-induced resistance in rats by edible bird nest might be partly because the reduction of oxidative stress by edible bird nest.

3.5. **Osteoarthritis prevention effect**

Edible bird nest is rich in proteoglycans containing non-sulfated chondroitin glycosaminoglycan that has similar property as the cartilage matrix [21]. The authors reported that 0.5-1.0% of edible bird nest extract prepared with hot water extraction improved the proliferation of human articular chondrocytes [21]. In addition, edible bird nest also reduced the catabolic activities by reducing the expression of catabolic genes such as matrix metalloproteinases. This is because sialoglycoprotein found in edible bird nest is a cartilage matrix material. Therefore, edible bird nest could be used to control the progression of osteoarthritis and promote cartilage cells to regenerate [21].

3.6. **Improved bone strength**

In a study investigating the effect of oral administration of edible bird nest extract on calcium level and bone strength in the femur of ovariectomised rats, Matsukawa et al. (2011) reported that edible bird nest extract increased the dermal thickness, calcium, phosphorus and hydroxyproline levels in rats. Therefore, edible bird nest might possess the potential for improving bone loss [22].

3.7. **Immune promotion**

Edible bird nest has been traditionally used as a food that can enhance immunity. A study by Mei et al. (1994) reported that after the supplementation of edible bird nest plus pearl powder extract to rats and mice, the DNA synthesis of T-lymphocytes, the levels of serum immunoglobulin M (IgM) and superoxide dismutase (SOD) were increased [23]. The authors suggested that the extract possess an immuno-enhancing property [23]. Another study by Zhao et al. (2016) reported that edible bird nest promoted the activation of B-cells and improve the concentrations of IgM, IgA, IgE and IgG3 [9].

3.8. **Neuroprotective effect**

Edible bird nest has been shown to exhibit neuroprotective effect [24]. In a study investigating the effect of edible bird nest extract in the neurotoxin-induced in vitro Parkinson’s disease model, Yew et al. (2014) found that the extract lowered the level of neurotoxin 6-hydroxydopamine (6-OHDA)-induced apoptotic changes in human neuroblastoma SH-SY5Y cells and improved the cell viability [24]. Therefore, edible bird nest might be useful to protect against neurodegenerative disorder

4. **Conclusion**

Edible bird nest has been proven to possess pharmacological effects to human health such as immune system improval, neuroprotective effect, antioxidant, anti-viral and anti-inflammatory activities. The pharmacological effects are due to the nutritional contents and bioactive compounds in the EBN. It can be concluded that EBN is a functional food that has been used for many centuries to improve health despite of its scarcity.
5. References


