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Edible Bird's Nest (EBN): Production, Processing, Food and Medicinal Importance

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SUMMARY

Edible Birds Nest is the solidified saliva of the Swiftlets usually produced, consumed as food and medicine in south Asian countries. These EBNs are rich source of protein and considered for many health benefits in traditional scripts. However, Recent research is actively proving different benefits of EBNs on human health. Due to the higher demand in the market and lower availability EBNs reported for adulteration. Researchers are discovered modern techniques for determination of authenticity of EBNs. Finally, this article is composed the information on biological mechanism of edible nest formation, Location, distribution, and business, Harvesting and processing for food preparation, Nutritional composition, Medicinal benefits, and adulteration.

INTRODUCTION

Human is an omnivorous consumes different kinds of foodstuffs including both plants as well as animal based food products. They can be either sacrificial or non-sacrificial. Generally, animal based food products involve sacrifice, whereas plant based food products are generally non-sacrificial. Animal products consumed by human beings include – fish, poultry, meat, egg, etc. Although consumption of animal food products include sacrifice, but special animal product known as the "Edible Birds Nest (EBN)," the speciality being non-involvement of sacrifice of any limb of the animal.

It is made up of solidified saliva of the Swiftlets – mainly black nest swiftlets (*Aerodramus maximus*), white nest swiftlets (*Aerodramus fuciphagus*), etc. These are harvested afterwards for consumption of human beings. It is primarily produced in South Asian countries, especially demanded for its delicious taste and high nutritional value. It was commonly referred to as the "Caviar of the East" as it is a highly regarded food product in the Eastern Countries. It was also reported for having several medicinal properties like anti-influenza, anti-inflammatory, anti-aging, neuro-protective, skin regeneration, bone strengthening effect, etc. In China, it is locally called "Yan Wo" and being used as a functional food as well as a traditional medicine from the time of Tang dynasty.

Figure 1. Outline of the Edible Birds Nest (EBN) processing and different food products from EBN.

Biological mechanism of edible nest formation

EBN is basically formed from the sticky and glutinous secretions of swiftlet's sublingual salivary glands, that are highly produced during their breeding and nesting seasons. After the secretions are regurgitated,

they are hardened upon exposure to air. Along with the secretions, other materials like feathers, seaweed, mosses get included ultimately leading to formation of nest. Among various species of swiftlets, the majority of EBNs produced are built by mainly three species of cave swiftlets – *Aerodramus maximus, Aerodramus fuciphagus*, and *Collocalia esculenta*. However, it was found that 85%–90% constituents of the nests from black nest swiftlets are feathers, along with the remaining 10%–15% constituting edible portions. 95%–98% constituents of the nests prepared by *Collocalia esculenta* are feathers along with the remaining 1%-2% constituting edible portions. Nests of *Collocalia esculenta* and *Aerodramus maximus* are not proper for human consumption due to the presence of high impurities compared to edible part. The swiftlets generally build the nests in the walls of coastal caves. It takes approximately 35 days for male swiftlets to build the nests. Externally, EBN looks like the shape of a half-bowl, the curvature consisting of fine strands of solidified saliva and feathers; whereas the terminals being composed of thick and closely packed solid secretions. This particular shape makes the nest suitable for withstanding the weight of the hatchlings along with enabling them to remain rigidly attached to the walls throughout the total breeding duration. The unprocessed EBN has an approximate length of 5.0–10.0 cm and breadth of 3.5–6.0 cm. The thickness of the nest at the curvature is about 0.5–1.0 cm, whereas its thickness at the ends is approximately 1.0–2.5 cm, with 4.0–8.0g per piece in weight. The EBN available in white, orange and red. Although the reason of appearance of various colours is not confirmed till now, still several hypotheses are made regarding the difference in colours. One among the popular hypotheses is that swiftlet's blood released during nest construction is responsible for red colouration of the nest. Others suggest that the food sources of swiftlets (majorly insects) that are rich in minerals like iron (oxidized iron producing red colour), or particles discharged from limestone of cave walls are responsible for chromatic variance.

Location, distribution and business

Swiftlets are mainly found in South East countries from Andaman and Nicobar Island, in the Indian Ocean up to the coastal regions of Malaysia, Vietnam, Thailand, Palawan Island of the Philippines along with the South Eastern part of China. They settle on the surfaces of cave walls or nesting planks for building the nests. The most famous swiftlet nesting sites are Gomantong Cave and Niah Cave, which are located in Sabah and Sarawak, respectively, at Malaysia. Other nesting sites are also found in southern regions of Borneo islands, Indonesia. The darkness inside caves creates a suitable environment for swiftlets by giving them a natural protection against predators. Apart from that, strong smell of ammonia generated from the huge number of droppings released by swiftlets are major sources of deterrent to predate animals including humans. Nowadays, EBN are also being produced in specific swiftlet houses having ambient required conditions, which were helpful in maintenance of supply chain, ultimately leading to the expansion of EBN industry. Recent studies suggested that houses located in rural areas are the most suitable range for swiftlet adaptation. The ambient conditions essential for EBN production include temperature 30.1°C, light intensity 0.16 lux, relative humidity 83.7%, along with sound 68dB (external) and 47dB (internal). EBN market is generally found popular in Southeast Asian region, the estimated value of world's EBN production is worth more than MYR 10 billion. The history of the swiftlet industry is unique in the agricultural sector of Malaysia, which has increased since 18th century. Currently, Malaysia is in third rank among all total world's EBN production, that contributes 9% of the global supply, after Indonesia (60%) and Thailand (20%).

Harvesting and processing for food preparation

Harvesting is the process of scooping out the raw EBN from the swiftlets farm. For ensuring safety of the swiftlets, only vacant nests that are abandoned by the swiftlets after breeding are scooped. Raw EBNs are inspected with a swiftlet corner mirror for ensuring the absence of eggs or baby swiftlets. Raw EBNs are not consumed directly after harvest as it contains droppings, dirt, twig, etc. Therefore, they need to undergo cleaning and processing before being marketed for consumption. Initially, the raw EBN soaked in water for 1-2 hours till the partial loosening of the soft glutinous material. This leads to removing of impurities by floating like dirt and feathers. Further, impurities are manually removed by tweezers. Cleanliness of EBN determines visually with the help of magnifying lens. After cleaning, a plastic mould is used to give EBN a half-bowl shape. Nowadays, new technologies are implemented for enhancement of the cleaning process. For example, additional processes of

brushing and trimming are introduced in order to control the moisture and removing impurities by excessive water contact (due to soaking). In brushing, small amounts of water are added to the raw EBN, resulting a soft and elastic texture to the nest. Further, cleaned EBNs placed into the container and allowed to expand slightly. After feathers are separated in semi-dry condition for maintaining the nutrients along with the original shape of EBN. Afterwards, the cleaned bird nests are trimmed, followed by moulding. After that, they are placed in a ventilated cabinet until the they dry. The benefits of this newer developed approach include, reduced time in moulding and drying, retention of nutrients and quality of EBN, avoidance of risk of contamination through air or water, etc. Most recently, automated systems including machine vision system and industrial robots are also utilized for accomplishing better processing systems that reduce time and increase efficiency of processing. In addition, low-energy X-ray treatments are used to inactivate foodborne pathogens like *Escherichia coli* O157:H7 and *Salmonella typhimurium* in dry EBN. The dried EBN is temporarily stored in containers at room temperature. EBN is weighed according to the amount demanded by the customers further priced as per the weight. Bubble wrap or sponges are used for packaging in order to prevent the easy cracking of EBN.

Nutritional composition

The nutritional composition of EBN varies from regions to region, also depending on level of cleaning performed. The EBNs produced by A. *fuciphagus* was found that abundancy of nutrients varied from one country to another country. The protein content in EBN from the various regions ranged from 59.8% - 65.8%, which was indicator of EBN's high protein content. The carbohydrate content ranging between 8.5% - 16.4% was found as second most abundant component in all EBN samples. EBN from Philippines had slightly more carbohydrate content than EBNs from other locations. Sialic acid content ranged between 0.7% to 1.5%. The fat content ranging between 0.01% - 0.07% was found having the lowest composition in all EBN samples. The moisture analysis report showed that uncleaned EBNs had comparatively lower moisture than cleaned EBN. This change could be attributed to increase in moisture content of EBN during cleaning process. The ash content was also found lower, which can be due to EBN's composition, which is exclusively made up of saliva and being digestible. The minerals content found in EBN include mainly five minerals, namely calcium, magnesium, potassium, sodium, and phosphorous. The processed EBNs were found to contain higher amounts of minerals compared to unprocessed EBNs.

Roles in food

EBNs are widely used as traditional food in China since Tang dynasty (618-709 AD). Traditionally, EBNs double boiled with sugar and were consumed as soup, which had both nutritional and medicinal benefits. As the production came to a commercial level, variety of food products like beverages, food additives, etc. were prepared from EBN. EBNs are also consumed as flakes. Some of the recently developed EBN products are listed.

Table 1. Different food products produced from the Edible bird nests

No.	Product Name	Benefit
1	Bird's Nest Soup	Acts as a tonic as well as a nutrient rich traditional Chinese cuisine
2	Bird's nest instant energy drink	Can help in quick boosting of energy when the person is feeling fatigued.
3	Vietnam bird's nest powder	Helps in increasing the absorption rate as well as having anti-oxidant properties.
4	Bird's nest drink	Acts as a traditional medicine for improving blood circulation
5	Bird's nest pudding recipe	Delicious pudding made up of EBN extract
6	Instant Malaysian Cubilose nourishing tonic	A kind of traditional Chinese medicine
7	Bird's nest granules	Used as supplements

Use in traditional medicines

Just like usage in traditional Chinese cuisine, EBNs are also consumed as traditional medicine since Tang dynasty because of its pharmaceutical properties. As per ancient Chinese literatures, EBN enhances the skin complexion, reduces asthma, treats malnutrition, and strengthens the immune system. The above mentioned EBN soup was also consumed for enhancing beauty. According to Lim & Cranbrook (2002), intake of EBN was also advised as a medication. Also, some suggested EBN for curing cancer and AIDS. The Traditional Chinese Medicine (TCM) suggested EBN as a remedy for tuberculosis, consumptive illnesses, dry coughs, asthenia, general weakness of bronchial ailment, improving voice, haemoptysis, difficulty in breathing, and relieving gastric troubles. Apart from that, EBN is believed to promote growth, raise libido, increase metabolism, regulate circulation and improve concentration.

Medicinal benefits

Consumption of EBN has shown to bring multiple health benefits including antiviral effects, antioxidative actions, and neuroprotective effects, etc. It is also helpful in improving cardiometabolic diseases and bone degeneration. Some of the medicinal benefits of consuming EBN are listed below in Table 2.

Table 2. Medicinal properties of EBNs reported by different researchers

	Medicinal Property	Information
1	Antiviral Effects	Inhibition of influenza virus and reduces hemagglutination activity of H1N1, H3N2, and H5N1
2	Anti-inflammatory Effects	Inhibition of nitric oxide and TNF-α production
3	Against hyperglycaemia – induced oxidative stress	Reduced the expression of ROS markers (increased expression of SOD-1
4	Improves bone strength and calcium concentration	Proteoglycans consisting of non-sulphated chondroitin is one of the main components of the bone.
5	Prevents UV-B Irradiation – Mediated Oxidative Stress and consequent photoaging in the skin	Increases skin hydration by synthesizing hyaluronic acid and suppresses melanogenesis by the process of down regulation
6	Promotes sexual function of male castrated rats	Promotes the development of prostate glands and seminal vesicles, enhances secretion of testosterone
7	Chondro-protective agent	It reduces catabolic activities and increases cartilage extracellular matrix synthesis.
8	Reduce oxidative stress-induced apoptosis	Neuroprotective effect against 6-OHDA-induced degeneration of dopaminergic neurons, by inhibition of apoptosis.
9	Anti-oxidant properties	Bioactive compounds in EBN
10	Prevents high fat diet-induced insulin resistance	It prevents the worsening of metabolic indices and transcriptional changes in insulin signalling genes due to high fat diet
11	Improves the spatial learning performances in the offspring	Boosting the growth and promoting differentiation of neurons among their generations.
12	Pro-mitogenic effects	Increasing the mitogenic response of human peripheral blood monocytes in the presence of phytohemagglutinin A

Allergy by edible bird's nest

Allergens in EBNs from different sources are heterogenous and vary according to different regions. As EBN is composed of the saliva of swiftlets, the allergens, and their isoforms in it are mainly salivary proteins, swiftlet feathers, the insects eaten by the swiftlets, the arthropods (mites) and microorganisms associated with the

swiftlets, etc. Allergens can also be induced by inclusion of additives during processing. Some fungi found in the raw EBNs cause respiratory infections like *Cladosporium* sp. and *Eurotium* sp. EBN allergy was reported as one of the major causes of food induced anaphylaxis, surpassing other well-defined food allergens.

Fraudulent in EBN

The increase in demand of EBN along with being one of the rare and limited natural product has led to the production of numerous adulterated EBN products in global market. Additives were incorporated with the original EBN by unethical suppliers for mainly increasing the nest size and market value. The additives include – mushroom, agar, edible plants, algae, fish skin, red seaweed, sodium alginate, *Tremella* fungus, egg white, pork skin, etc. The natural colour – karaya gum, *Tremella* fungus and red seaweed are used widely for changing the colour of EBN from white to red, thus giving a more expensive "Red Blood" Bird's Nest. Gluten, white fungus, jelly, animal skins, synthetic rubbers, etc are often used for improvement of shape and appearance of the EBNs. Salt, sugar, and monosodium glutamate (MSG) are generally added for improvement of taste. Various preservatives added include – boric acid, potassium sulphite, sulphur dioxide, etc. The adulterants in EBN are grouped into two categories: Type – I and Type – II. The Type – I adulterants are solids like pork skin, fish bladder, coralline seaweed, karaya gum, tremella fungus and agar strips which adhere on the external surface of EBN cement. Type – II adulterants include water soluble substances which are adsorbed internally in the EBN cement matrix leading to the formation of composite after drying, making difficulty in their visual detection. These include – saccharides (Eg. glucose, sucrose), polypeptides (Eg. hydrolysed collagen) and salts (Eg. monosodium glutamate). Different methods are used for detection of the intensity of various adulterants along with inspection of purity in processed EBNs. The methods like Raman's micro spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy, Enzyme-linked immunosorbent assays (ELISAs), High performance ion liquid chromatography with pulsed amperometric detector (HPAE-PAD), TaqMan-based real-time polymerase chain reaction (PCR) assay, The Forensically Informative Nucleotide Sequencing (FINS), SYBR green I based real-time PCR, Thermal analysis by Thermogravimetry (TG) and Differential Thermogravimetry (DTG), Loop-mediated isothermal amplification (LAMP) are the most advanced methods developed in the determination of adulations in EBN. These all advanced techniques are highly used for assurance of quality and authentication of EBNs.

CONCLUSION

Since ancient time, EBN has been considered a famous traditional cuisine of China which is consumed not only as a nutritious functional food but also as a tonic. Various research works have supported the traditional belief about EBN offering multiple medicinal benefits. The EBN market has now enhanced with increasing demand, especially in Southeast countries like China, Malaysia, Vietnam, Hong Kong, Indonesia, etc. Different products of EBN like energy drink, flakes, soups, etc are available in market. As swiftlets farming is gradually becoming one of the major sources of income of the mentioned countries, the native practitioners have applied various techniques and policies for monitoring the safety and quality assurance of EBN. Hence, it can be roughly calculated that the EBN business will reach up to several hundred million dollars in foreign exchange, making its supply essential for the economies of major producers, like Thailand, Indonesia and Malaysia in future.

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