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COULD CHICKEN EGGSHELL POWDER BE THE SOLUTION IN DENTISTRY?

YUMURTA KABUĞU TOZU DİŞ HEKİMLİĞİNDE ÇÖZÜM OLABİLİR Mİ?

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Abstract

This review was made to give information about eggshell and its use in dentistry. Eggshell is a natural and biologically available source of calcium; thanks to the calcium and trace minerals it contains. Although it is not widely used in dentistry yet, it is used in different fields. While collagen was commonly obtained from cattle and pig skins in the past, since cattle caused diseases such as spongiform encephalopathy and foot and mouth disease, collagen was obtained from the eggshell membrane as a result of the search for alternative materials. Thus, with the use of eggshells, waste recycling and the development of biocompatible and economical materials have been achieved. Today, in the studies carried out in dentistry with eggshell; It has been observed that eggshell improves bone regeneration, stimulates remineralization, and has less cytotoxicity. With the increase in studies on this subject, it is expected to develop new restorative materials with eggshell-enhanced biocompatible, remineralization stimulating effect that can be used in many areas of dentistry in the future.

Keywords: *eggshell, eggshell powder, eggshell in dentistry.*

Özet

Bu derleme yumurta kabuğu ve diş hekimliğinde kullanımı hakkında bilgi vermek amacıyla yapılmıştır. Yumurta kabuğu, içeriğinde yer alan kalsiyum ve eser mineraller sayesinde doğal ve biyolojik olarak kullanılabilirliği yüksek bir kalsiyum kaynağıdır. Diş hekimliğinde henüz çok yaygın olarak kullanılmasa da farklı alanlarda kullanımı mevcuttur. Kollajen, geçmişte yaygın olarak sığır ve domuz derilerinden elde edilirken, sığır süngerimsi ensefalopati ve şap hastalığı gibi hastalıklara neden olduğundan alternatif malzeme arayışları sonucunda yumurta kabuğu zarından kolajen elde edilme yoluna gidilmiştir. Böylece yumurta kabuğu kullanımı ile atıkların geri dönüşümü, biyouyumlu ve ekonomik materyallerin geliştirilmesi sağlanmıştır. Günümüzde yumurta kabuğu ile diş hekimliğinde yapılan çalışmalarda; yumurta kabuğunun kemik rejenerasyonunu iyileştirdiği, remineralizasyonu uyardığı, daha az sitotoksiteye sahip olduğu gözlenmiştir. Bu konu ile ilgili çalışmaların artması ile gelecekte diş hekimliğinin birçok alanında kullanılabilecek yumurta kabuğu ile güçlendirilmiş biyouyumlu, remineralizasyonu uyarıcı etkiye sahip yeni restoratif materyallerin geliştirilmesi beklenmektedir.

Anahtar Kelimeler: *diş hekimliğinde yumurta, yumurta kabuğu, yumurta kabuğu tozu.*

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OVERVIEW / GENEL BAKIŞ

Eggshells are obtained from poultry and kitchen waste. With the increase in egg use in the industries, eggshell waste has increased. Disposal of waste material contributes to the prevention of environmental pollution. But the cost of this procedure process is high, the eggshell can be converted into other products such as fertilizer and collagen can be produced from the membrane to ensure environmental sustainability[1].

Eggshell calcium and traces of microelements; It contains magnesium, boron, copper, iron, manganese, molybdenum, sulfur, silicon and zinc. The calcium in the eggshell can be absorbed by about 90%, it is the best natural source of calcium[2]. Eggshell extract, which has a large amount of Ca oxide and carbonate content, is an economical choice for obtaining hydroxyapatite. Recently, it has been reported that nanobiomaterials release more Ca, fluoride (F) and P ions from microparticles[3].

Eggshell membrane:

The composition of the eggshell is similar to the structure of the bone and teeth. The eggshell consists of the calcified shell and the crust membranes, internal and external[4]. Eggshell membrane contains type I, V and X collagen, cysteine-rich proteins[5], proteoglycans[6], hyaluronic acid[7]. Dupoirieux et al. (2001) reported that the stable structure of the eggshell membrane can compensate for the deficiencies of other biopolymers thanks to its low immunogenicity[8]. Since the collagen obtained from the skin and bones of cattle and pigs causes bovine spongioform encephalopathy (mad cow disease), autoimmune and allergic reactions, the portion obtained from these sources has been restricted. The search for alternative sources resulted in collagen obtained from the eggshell membrane being found to be good for biosecurity[9]. It has been reported that the eggshell membrane requires very little production when it is desired to be reused due to its biological and mechanical advantages[10].

Eggshell; It is also used in dentistry along with areas such as soil stabilization as an alternative to lime[11], construction industry as an alternative to sand[12], increasing muscle gain in cancer patients, osteoporosis treatment, cosmetic and burn surgery (plastic surgery)[13]. Hydroxyapatite[14,15] in the tooth structure can also be produced from the eggshell. Hydroxyapatite, one of the few bioactive materials, is used to promote bone growth and osseointegration in dental and maxillofacial applications[16,17].

Eggshell is considered the best natural form of calcium[13]. However, the calcium carbonate contained in it dissolves in an acidic environment. This limited the use of eggshells to ensure enamel remineralization in the prevention of caries. However, this problem was overcome by modifying the eggshell powder with titanium dioxide[18]. When vitamin D3 is added to eggshell powder, it has been observed that it improves the concentration of minerals in the bone without increasing blood calcium

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levels[13]. It has been reported that eggshell powder can stimulate chondrocyte differentiation and cartilage growth as in vitro. Since it increases bone mineral density in post-menopausal and senile osteoporosis women, it can be used orally for 12 months for the prevention and treatment of osteoporosis[19,20].

In dentistry, studies have been carried out in different areas related to eggshell.

a) Orthodontics/Periodontology

The main complaint of patients in the field of orthodontics may be the length of the treatment period. This situation brings with it consequences such as deterioration of cooperation of patients and inability to complete the treatment. This has been associated with the acceleration of wound healing of type 1 collagen in the eggshell[21]. It has been stated that the hydroxyapatite content of the eggshell can be used to provide bone regeneration. Since it is a cheap, sustainable and biocompatible material for bone regeneration, it is promising in terms of applicability in dentistry and medicine[22].

b) Restorative Dentistry/Endodontics

When eggshell is added to acrylic resin, it has been observed to improve mechanical properties such as elastic modulus and it has been reported that it can be used as a more economical alternative[23]. It was observed that mechanical properties improved when eggshell powder was added to cross-linked cystose composites. It is also predicted that cheaper composites can be produced with the use of this new filler material[24]. Glass ionomers, one of the restorative materials, release fluoride, calcium and phosphate ions, strengthening the tooth structure against acid attacks. When 5% eggshell powder was added to the GIC, it was observed that calcium release increased so that remineralization capacity could be increased[24]. Addition of eggshell powder to tricalcium silicate-based materials such as MTA and Biodentin can increase the bioactivity of these materials and improve the marginal adaptation at the dentin/material interface[25].

Calcium hydroxide is widely used in direct pulp cover for hard tissue repair. Although calcium hydroxide has several advantages, when calcium hydroxide is used, the bridge of pöröz and missing dentin is formed. Therefore, the search for alternative materials to calcium hydroxide still continues[26]. The bioactivity of mta and biodentin, the end product of which is calcium hydroxide, depends on the hydrophilicity of their particles, which increases their solubility with the release of ions. When eggshell powder was added to these materials, it was observed that their bioactivity increased and improved marginal adaptation at the dentin/restorative material interface[27]. In a study using rabbit teeth, calcium hydroxide and eggshell powder were applied to the same tracking points and pulp cover was performed directly. Teeth treated with calcium hydroxide had a more extensive inflammatory response with more severe fibrosis than those treated with eggshell powder; It has been reported that the dentin bridge is thinner[28]. This result can be attributed to the magnesium and trace fluoride content

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of the eggshell. Magnesium ions added to apatite crystals promote bone formation by accelerating osteoblastic adesion in apatite[29]. Fluoride, on the other hand, forms fluoridated hydroxyapatite, making the hydroxyapatite more stable[30].

Although fluoride is a useful element, its excess can cause some problems. Excess fluoride in drinking water is a common problem in countries such as India[31]. Excessive fluoride intake can lead to calcium loss in the tooth[32]. To avoid this situation, some researchers have used calcium-containing materials to remove high levels of fluoride from the water[33,34]. Eggshell with its high calcium carbonate content has also been used for this purpose and it has been reported that it can be a simple, economical and effective method[35]. Thus, the problem of eggshell waste can be avoided.

Thanks to the increase in information about the processes of dental caries and technological developments, the perspective of dentistry towards caries and therefore the intervention methods is changing. The understanding that adopts restoration has been replaced by the concept of "minimal intervention", which is based on biological solutions, rational therapeutic strategies and adopts the principle of least intervention[36]. Dental caries begins at the ultrastructural level and continues with early lesions in the enamel. There are three different stages of dental caries: the later inclusion of dentin and the stage with open cavitations. The new perspective includes preventive/protective applications targeting the stages of this process before cavitation occurs. Minimally invasive dentistry includes prevention of caries, remineralization of initial lesions, and restoration or repair with the principle of minimal tissue loss[37]. For the purpose of remineralization

- fluoride treatments,

- treatment with products containing calcium phosphate,

- treatment with antimicrobial products is applied.

In studies with eggshell powder, fluoride varnish showed more remineralization than eggshell powder in initial enamel caries, but eggshell powder may be preferred because it is a natural source of calcium and phosphate and is easily bioavailable[38]. Haghgoo et al. reported that eggshell was as effective as nanohydroxyapatite in remineralization of initial enamel caries[39]. Nanohydroxyapatite can neutralize the acids that cause demineralization in the tooth and also promotes remineralization by providing calcium with high bioavailability[40]. In addition, it has been reported that the use of biological or bioactive components instead of remineralizing fluoride in the content of dental polishes can reduce cytotoxicity[41]. With the developments in this field, its use for remineralization is expected to increase in the future[38].

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c) Oral and Maxillofacial Surgery

The fact that autografts and allografts have some limitations[42] has led to the search for alternatives. Hydroxyapatite in the mineral component of bone; It is a good alternative for regeneration because it is biocompatible, does not have the risk of disease transmission unlike allografts, and can be obtained from eggshells. In a study using nanohydroxyapatite and platelet-rich fibrin (PRF), good bone regeneration was reported in sockets[43]. Kattimani et al. reported that hydroxyapatite obtained from eggshell showed an increase in regeneration compared to the control group. Since it is obtained from eggshell, it can be said that it is an environmentally friendly and economical graft material[44]. In guided bone regeneration, it has been observed that the eggshell membrane stimulates osteoblast proliferation and angiogenesis by preventing epithelial migration[45]. This result shows that the eggshell membrane can be combined with a commonly used xenograft other than eggshell powder in guided bone regeneration in the future[46]. The lack of cytotoxicity of the eggshell membrane at implantation in vivo has been associated with a low dead cell rate and minimal inflammation[8,47,48]. We can predict that in future studies in the field of bone regeneration, we will frequently encounter studies in which eggshell is used in combination with regenerative materials/compared.

SUMMARY / SONUÇ

Considering that eggshell can be used in many areas, when eggshell waste is used, environmental pollution is prevented and employment can be provided in many fields, especially in the economy. The advantages of eggshell powder/membrane have opened up new opportunities for its use in dental practice. Since eggshell contains minerals such as calcium and phosphate, it can be a highly bioavailable alternative for remineralization treatments, which have gained importance especially in dentistry in recent years. However, it can be a material that can contribute to the development of inorganic structures of restorative materials that are biocompatible with teeth and surrounding tissues. With the developing technology, more studies are needed to popularize the use of eggshell in dentistry.

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