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Review Article: High Calcium Boba from Egg Shells to Prevent Stunting and Boost the Immune System

Laillatul Mas'udah, Dhani Wijaya*, Nabila Asha Rahmita, Ulva Nur Rahmawati

Program Studi Farmasi, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Malang, Indonesia
*Email Korespondensi: dhanishalas@gmail.com

Abstract

Nutritional status and stunting are problems in several countries, including Indonesia. Calcium is one of the important micronutrients to prevent stunting, and the immune system can act as a second messenger of lymphocytes to maintain the body's immune response. Calcium in eggshells can be processed into boba which is popular in the community. This study aims to examine eggshells as a high-calcium food source to prevent stunting and help increase immunity. This research is a Literature Review of open access articles published in 2016 - 2021 on Google Scholar, PubMed, and Science Direct. Duplicate reports were excluded from the study. The keywords used in searching the journal in the database are eggshells, calcium, stunting, immune system, and popular foods. Research shows that every gram of eggshell contains 381 mg of calcium. Adequate calcium intake supports increasing height, maintaining bone health, and preventing stunting. Increased intracellular calcium is essential for the steps of intracellular signaling that induce proliferation, cytokine production, and regulation of several transcription factors. Eggshells can be safely consumed if they are kept for 20 minutes and finely ground with the high calcium content. High calcium boba from eggshell flour can prevent stunting and boost the immune system.

Keywords: Eggshell; Boba; Calcium; Stunting; Immunity

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1 Introduction

According to the Ministry of Health at the National Statistics Agency in 2022**,** the prevalence of stunting in Indonesia shows that Indonesia still has a high stunting rate of 21,6 % [1]. The World Health Organization (WHO) classifies the stunting incidence rate of 30-39% as the high prevalence category, and Indonesia includes in the class. The World Health Organization and the United Nations (UN) on the Sustainable Development Goals (SDGs) program called for a 40% reduction in childhood stunting by 2025 with the ultimate goal of eradicating all malnutrition in children [2].

One of the health problems in Indonesia high is malnutrition, which can trigger stunting. Stunting in children is the impact of nutrient deficiency during the first thousand days of life [3]. Stunting causes irreversible children's physical development disorders, resulting in decreased cognitive and motor abilities and reduced work performance. Inadequate food intake over a long time and chronic disease presence can result in stunted growth [4]. Calcium intake plays a significant role in bone demineralization and linear growth. Adequate calcium consumption can reduce the incidence of stunting [5].

Besides having a function in the process of bone demineralization and linear growth, calcium plays a role in activating immune cells. The body's immune system has an important role, namely protecting the body from harmful substances, germs, and cell changes that can cause illness. The immune system includes all the structures and processes of the body's defense against germs, which can be grouped into two categories: the innate immune system is non-specific, and the adaptive immune system is specific. Some cells, such as lymphocytes, react to antigens in the immune system. Most immune cells are produced from the bone marrow [6-8] in children.

Adequate calcium (<25% daily requirement) affects the incidence of stunting in children [9]. Lack of potassium intake can cause stunting and disruption of the body's biochemical and physiological processes, including the function of the immune system. Innovation to find a cheap source of calcium that can be easily absorbed by the body and is acceptable is important [10].

Egg shells can be a cheap and easy source of calcium. Egg consumption in Indonesia reaches 0.129 kg/capita/week or equivalent to 1826.51 thousand tons per year [11]. The calcium content in eggshells is relatively high, more than 80% [12]. Therefore, eggshells can be an alternative source of calcium.

Egg shells can be processed into food raw materials such as flour. High-calcium flour derived from eggshells can be processed to become most popular food and can be a solution to the stunting problem in Indonesia. There has been a growing variety of food and drink in society. Boba is one of the popular food products and is easily accepted by the public [13]. Eggshell flour with calcium content can also be an alternative food consumed to support the immune system. However, no research discusses eggshells in high-calcium boba to prevent stunting and its role in increasing immunity. Therefore, this research aims to determine the benefits of egg shells in high calcium boba to prevent stunting and it is role in increasing immunity.

2 Methods

This research is a literature review of articles published from 2016 to 2021. Reports are obtained from Google Scholar, PubMed, and Science Direct, where all three are large journal databases, widely used as references in the research world, and integrated with keyword specialists such as Medical Subject Headings (MeSH) and the scientific prestige of the indexed items. Duplicate articles on the database were

excluded from the study. The keywords used in the search for journals in the database are eggshells, calcium, stunting, immune system, and popular foods.

3 Result and Discussion

This research is a literature review. The data used in this study is secondary data, where data is taken from previous research data. The search libraries used include: PubMed and Scopus in the form of journals. The reason for using PubMed is that PubMed / MEDLINE has advantages in its integration with the vocabulary of specialist Medical Subject Headings (MeSH) as well as the scientific prestige of the indexed items. While the reason for using Scopus is that Scopus is one of the largest journals and is widely used in the world in terms of research. Scopus is also one of the best journals that is widely used in terms of publishing scientific papers. This literature review was synthesized using the narrative method by grouping similar extracted data to answer the objective. The data is then searched for similarities and differences, then discussed to draw conclusions. Below are the results of the identification of the literature review :

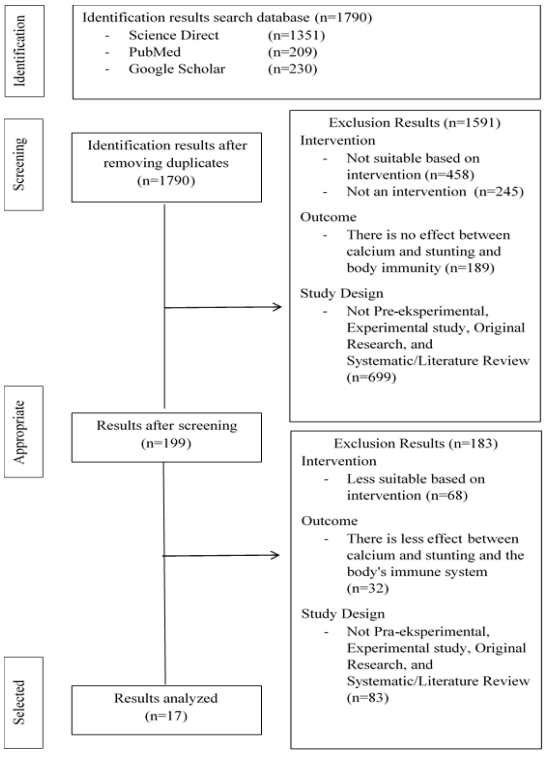

Figure 1. identification of the literature review

3.1 Calcium Content in Eggshell Waste

Calcium is an important mineral for the health of the human body for various physiological functions and maintenance of bone tissue throughout life. In addition, calcium plays a role in preventing bone demineralization [14].

Egg companies in Indonesia and several other food producers use eggs and leave eggshell waste. Every gram of eggshell contains 381 mg of calcium. Consuming 2.7 grams of eggshells can meet the calcium needs of adults [15]. Because of its calcium content, various ways have been developed to utilize eggshell waste to meet the body's calcium needs [16]. Research shows that the calcium content of eggshells can increase bone mineral density, reduce pain sensation, and increase mobility in osteoporosis patients [17]. The benefit of calcium from eggshell powder is influenced by its high bioavailability compared to commercially available calcium [18].

A study compared the content of bread with the addition of eggshell calcium with a variety of other nutrients such as lysine, vitamin D3, and vitamin K. The results showed that the calcium content in bread increased 2.5 times than bread without the addition of eggshell calcium. The study also explained that the addition of lysine, vitamin D3, and vitamin K increased the absorption of eggshell calcium in the body [19]. The addition of eggshell flour in foods such as biscuits, cereals, and bread can add up to 15% eggshell flour without disturbing the food's texture, taste, color, and aroma [20]. As a source of calcium, eggshells can be safely consumed if stored for 20 minutes and finely ground [21].

3.2 Calcium can Prevent Stunting

Calcium is the most abundant mineral in the body. About 99% of calcium is found in bones and teeth, while the rest is found in blood and extracellular fluids. Although only 1% of calcium is in the extracellular and intracellular fluids, calcium has very important functions for the body. Apart from functioning for the formation of bones and teeth, calcium in the blood plays a role in maintaining the acid-base balance regulated by vitamin D, the hormone calcitonin, and PTH (Parathyroid Hormone). In addition, calcium also plays a role in the

absorption of vitamin B12, regulation of fat-breaking enzymes, pancreatic lipase, insulin excretion by the pancreas, and the formation and breakdown of acetylcholine [22]. The level of calcium adequacy is significantly related to stunting cases [23]. Pregnant women's calcium intake in the first trimester affects childhood bone mass and increases maternal calcium absorption during pregnancy. Mobilization of calcium from the mother's bones can provide calcium for the growing fetus and baby [24]. Rickets in the baby's bones can occur as a consequence of calcium deficiency. In children, calcium deficiency can cause growth delay and become one of the causes of Stunting [25].

Adequate calcium intake impacts health, namely, supporting increasing height, maintaining bone health, and preventing stunting, and also supports the value of Sustainable Development Goals (SDGs) no. 3, namely good health and welfare.

3.3 Calcium Consumption Can Boost the Body's Immune System Sistem

Calcium has a role in the immune system, which plays a role in phagosome maturation. As in responses mediated by other membrane receptors, the process of phagocytosis requires signal transduction to cytoplasmic effectors. This signaling process has a complicated mechanism. This is because the signaling process does involve the formation of phagosomes and maturation and subsequent operations. In the process of phagocytosis, there is also a temporary increase in cytosolic calcium. During the phagosome maturation process, components of the endocytic pathway contribute to calcium alteration. Endosomes and lysosomes fuse to form phagosomes and direct the maturation to early, late, and phagolysosomal stages. The occurrence of endomembrane fusion is dependent on transient calcium. These processes have a vital role in cell biology infection control, the development of autoimmunity diseases, and several other clinical problems [26].

Calcium also has a role in the immune system, namely as a Calcium Sensing Receptor (CaSR). Epithelial CaSR has a role as an important regulator of gut barrier integrity and immunity and a sensing modulator of gut bacteria. Epithelial CaSR deficiency results in reduced intestinal barrier function and initiates changes in the composition and distribution of gut bacteria. This process can stimulate a pro-inflammatory response [27]. Increased intracellular calcium is essential for the steps of intracellular signaling that induce proliferation, cytokine production, and regulation of several transcription factors such as NFAT (Nuclear Factor of Activated T Cells), NF-B (Nuclear Factor kappa-light-chain-enhancer of activated B cells), or CREB (cAMP Response Element Binding) which plays a role in the immune system [28].

3.4 Boba is Becoming a Popular Food

In this research boba was used because boba is a popular food that is liked by all groups, especially among young people. boba has become a popular food globally, where people of all generations feel the addiction and pleasure when chewing the soft texture of boba pearls. This is supported by boba's relatively low or affordable price [29]. The raw materials for making boba are generally tapioca flour and water. The nutritional content of tapioca flour per 100 g sample is 362 cal, 0.59% protein, 3.39% fat, 12.9% air and 6.99% carbohydrates [30]. Based on these data, it is known that tapioca flour does not have sufficient nutritional content, especially calcium needs. Replacing tapioca flour with flour derived from egg shells become an alternative to increasing calcium in the body in a fun way and can be accepted by both children and adults.

4 Conclusions

Lack of calcium intake in children can inhibit growth and be at risk of causing stunting. Calcium plays a role in intracellular signaling in the immune system. Therefore, eggshell calcium can be processed into a food source with a high calcium content. Boba, made from eggshell flour, is a popular alternative food that people like. Eggshells that have been processed into high-calcium boba can increase body immunity during the COVID-19 pandemic.

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