A Description Of Natural Extract Methods From Bovine Bone For Dental Implant

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Abstract

Purpose: The most widely used material for bone graft substitutes and dental restorations is hydroxyapatite. The weakness of hydroxyapatite is that it cannot resemble the composition of natural apatite, which includes additional elements such as Na, Mg, and Al. To produce hydroxyapatite that can resemble human bone apatite, it is necessary to extract it from natural sources such as cow bones because they contain 93% hydroxyapatite (HA) and 7% β-Tri Calcium Phosphate (β-TCP) which are calcium phosphate compounds that have potential in tissue engineering and as a raw material for making hydroxyapatite. The purpose of this paper is to provide an overview of the best natural extraction techniques to make affordable, good quality, environmentally friendly hydroxyapatite that is suitable for use as a dental implant coating.
Results: The results of the extraction method used are the calcination method because this method produces hydroxyapatite with high crystallinity, faster processing time, cost-effective, minimal chemical use, and environmentally friendly.
Keywords: Hydroxyapatite, Dental Implant, Bovine Bone, Natural Extract Method

Introduction

Hydroxyapatite (HA, HAP, Ca10 (PO4)6 (OH)2) constitutes the primary mineral component of human bones and teeth. It exhibits excellent biocompatibility, biological activity, stability, bone conduction ability, biodegradability, and bone formation induction, making it an almost ideal substitute for dental implants [1][2][3]. However, hydroxyapatite has drawbacks such as low strength, poor toughness, difficulty shaping, and poor corrosion resistance [4][5][6]. Therefore, it is necessary to prepare hydroxyapatite with superior comprehensive properties. One way to achieve this is by extracting hydroxyapatite from natural sources, which is more economical and environmentally friendly [7][8][9]. Another alternative method for producing hydroxyapatite that can imitate human bone apatite is by extracting it from natural sources such as cattle bones, which contain inherent inorganic minerals and are also economical and environmentally friendly [6][10].

Bovine bone contains 93% hydroxyapatite (HA) and 7% β-Tri Calcium Phosphate (β-TCP), a member of calcium phosphate compounds with potential in tissue engineering and as a basic material for making HA [10][11]. Various methods for producing HA from bovine bone extract include calcination, precipitation, hydrothermal, and alkaline hydrolysis [2][4][5]. The research that have extracted bovine bone to produce hydroxyapatite is show in table 1.

Table 1. Presents several research reviews on techniques for extracting hydroxyapatite from bovine bones.

No	Author	Metode	Findings	Objective/aim
1.	D. Canon et al, 2023 [12]	Calcination	Hydroxyapatite was produced at a sintering temperature of 700 °C.	Bone-tissue Engineering.
2.	Anggelica et al, 2023 [13]	Calcination	Hydroxyapatite was produced at a sintering temperature of 600 °C.	Bone-tissue Engineering.
3.	W. Kho et al, 2015 [10]	Calcination	Hydroxyapatite was produced at a sintering temperature of 700 °C & 900 °C that is produced is ≤ 125 µm.	Biomedical
4.	Mohamed et al, 2022 [14]	Calcination	The hydroxyapatite grain size from 21,7 nm	Bone-tissue Engineering.
5.	Arokiasamy et al, 2022 [4]	Mechano chemistry	Hydroxyapatite produced by nano	Bone-tissue Engineering.
6.	Forero et al, 2021 [5]	Thermal	Hydroxyapatite was produced at a sintering temperature of 1100 °C.	Bone-tissue Engineering.
7.	Hassent et al, 2016 [15]	Thermal	Hydroxyapatite was produced at a sintering temperature of 1000 °C with Ca/P 1,67.	Biomedical
8.	Guoqing Ma, 2019 [2]	Hydrothermal	The hydroxyapatite that is produced is crystalline.	Bone-tissue Engineering.
9.	Odusote et al, 2019 [8]	Calcination	The hydroxyapatite that is produced is < 250 µm.	Dental Implant
10.	Nuning et al, 2018 [16]	Alkaline Hydrolysis	Hydroxyapatite carbonate with an average crystal size of 10-12 nm.	Bone graft
11.	July et al, 2018 [3]	Calcination	The resulting hydroxyapatite (HAp) is highly crystalline and its behaviour in vitro is comparable to that of commercially available CHAp.	Bone-tissue Engineering.

12.	Harilal et al, 2018 [17]	Mechano chemistry	The produced hydroxyapatite is non spherical, nano and agglomerated.	Bone-tissue Engineering .
13.	M. Pu'ad et al, 2019 [18]	chemistry	The hydroxyapatite that is produced nano.	Bone graft
14.	Fifi et al, 2020 [11]	Calcinatio n	Cristallity 95 % and group OH^- PO_4^{3-}, CO_3^{2-}	Material precursor
15.	Shemshad et al, 2018 [19]	Calcinatio n	The resulting HA is porous at a sintering temperature of 750 °C	Bone-tissue Engineering .
16.	Yuli et al, 2018 [20]	Calcinatio n	Hydroxyapatite was produced at a sintering temperature of 800 °C that is produced is ± 250 µm.	Bone-tissue Engineering .
17.	Joko et al, 2020 [21]	Calcinatio n	Hydroxyapatite is produced by nano.	bone filler
18.	Reflin et al, 2017 [22]	Wet	Produces HA with a high level of purit	scaffolding

Methods

The research will employ a qualitative method, which can be seen in Figure 1 as follows:

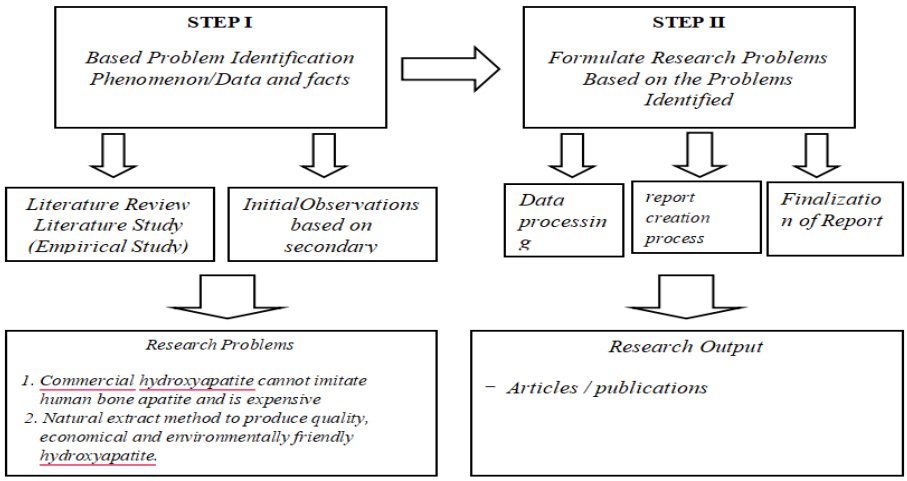

Figure 1. Research Flow Chart

The research flow diagram in Figure 1 is illustrated, where this research was carried out in 2 steps, namely: the first one started with the determination of the problem by searching for literature related to this research through journals and the internet, followed by initial observations of the problems that will be carried out in this research. Step two is problem statement and data preparation and report writing.

Results

Research by Canon et al, 2023 [6] using the calcination method from bovine bone, produces HA at a temperature of 700 ℃ which is used for bone tissue engineering applications. In a research by Anggelica et al, 2023 [17] used the calcination method from bovine trabecular bone, producing HA at 600 ℃ which is used for bone tissue engineering applications. The same method was used by Mohamed et al, 2022 [10] on bovine bone to produces HA at 700°C and 900°C which is used for biomedical applications. Nguyen et al. 2022 [18] also used the method of calcinination on bovine bone, which produced HA with a grain size of 21.7 nm, which is used for bone tissue engineering applications. Jamiu et al, 2019 [11] applied the calcination method from bovine bone and the HA was produced with a size of < 250 μm, which is used for dental implant applications. July et al, 2018 [22] in their research used the calcination method on bovine bone to produce highly crystalline HAp for use in bone tissue engineering applications. Researchers W. Kho et al, 2015 [10] used calcination on bovine bone to produce hydroxyapatite (HA) particles ≤ 125 μm in size for bone grafting applications.
Arokiasamy et al. 2022 [5] also made nano HA for bone tissue engineering applications from bovine bone using the mechanochemical method. In the same way, Harilal et al, 2018 [17] using mechanochemical methods from bovine bone, produced nano HA that was not spherical and agglomerated. Forero et al. 2021 [19] also used thermal methods from bovine bone to produce HA at a temperature of 1100°C, which can be used for bone tissue engineering applications. Hassent et al. 2019 [20] produced hydroxyapatite (HA) at 1000°C with a Ca/P ratio of 1.67 using the same thermal method from bovine bone, which is used for biomedical applications. Gouqing, 2019 [2] using the hydrothermal method from bovine bone, produced crystalline HA which is used for bone tissue engineering applications.

Discussion

The research opinions above, according to Arokiasamy et al, 2022 and Harilal et al, 2018, extracting hydroxyapatite by mechanochemical method is cytoxicity, hazardous chemicals and high cost. On the other hand, Guoqing Ma, 2019 and Aisah et al. 2018 on the "extracting hydroxyapatite by hydrothermal method and alkaline hydrolysis method" is simple, the sintering temperature is relatively low, the reaction conditions are moderate, and the resulting hydroxyapatite has high crystallinity. Forero et al, 2021 and Hassent et al, 2019 extracted hydroxyapatite using the Thermal Method, which is costly and environmentally unfriendly. Calcination methods are commonly used by other researchers, such as D. Canon et al, 2023, Anggelica et al. 2023, Mohamed et al, 2022, Nguyen et al, 2022, Jamiu et al, 2019, July et al, 2018, and W. Kho et al, 2015, due to their economic advantages, production of highly crystalline hydroxyapatite, rapid processing, and environmental friendliness.

Conclusion

The calcination method is a widely used technology for It is a process used to produce hydroxyapatite by heating it to remove water and carbon dioxide. This method is preferred due to its fast and economical production process, minimal chemical requirements, and environmentally friendly nature.

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