Comparison Of the Chemical Composition of Portland Cement Vs. Calcined Molluscan Shellfish Waste

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Abstract

The objective of this paper is to compare the chemical composition of portland cement versus calcined mollusk wastes from the city of Chimbote. The type of research was basic, with a descriptive design. The population was all the calcined mollusk waste from the city of Chimbote. The sample was 10 kg of fan, snail and mule's foot shells. Through X-ray fluorescence and energy dispersive spectroscopy (EDS) tests, it was obtained that the main component of the mule's foot mollusk is calcium oxide (99.627%), of the snail is calcium oxide (99.5478%) and of the fan, the shell is calcium oxide (80.755%) and sulfur oxide (12.044%). The cement is composed of a great percentage of calcium oxide (60.00%), silicon dioxide (19.50%) and aluminum oxide (5.00%) which can be replaced by the mollusks studied in this research, but it requires a previous treatment to add the other components of the cement so that it does not lose its properties.

Key Words: cement, coastal, mollusk, properties, residues.

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Introduction

The Peruvian sea has an infinity of richness and fishing resources that it provides to the inhabitants of the country's coastal areas. Its use and employment of these resources are represented by the various events of expansion and crisis, producing impacts on its economic resources at the local, regional and national levels (González, 2010).

The cultivation of fan shells (...) is one of the most important activities in Peru. It has been cultivated using the bottom cultivation technique, which contributes to more than 80% of the national production (Chu, 2019).

The growth of this industry has generated an environmental problem, which results in 100,000 metric tons per year of waste from this mollusk. At present, it has correct management and reuse of this waste and there is no concrete proposal that helps to reduce this impact (Carrillo, 2019).

The main problem of aquaculture activity is the increase of extractions from its countries, causing many mollusk shell wastes to be disposed of without treatment. On the Peruvian coast, there are about 200 to 300 tons of accumulated waste of fan shells, which are not being treated in the search for their reuse. This material has a high content of calcium oxide in its chemical composition, which is a component similar to limestone powder used in the manufacture of portland cement (Wegian, 2021).

Concrete is one of the main materials used in the construction and housing sector, due to its durability, cost

and workability; generating multiple impacts on the environment, and it must be sought ways to mitigate from its conception as a material, its production and application in buildings (Lazo, 2014).

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In Latin American countries, a crisis is beginning to be observed in the demand, trade and production of cement, one of the main materials that together with the fine and coarse aggregate and the addition of water produce fresh concrete. This has caused manufacturers to study multiple alternatives to satisfy the demand, generating multiple cements with a series of additions (Salamanca, 2001).

Cements with additions are mixed with Portland cement, proportions of gypsum and other added materials. To elaborate these cements it is required that their grinding process is carried out jointly or through the union by mixing their previously ground compounds (Bolognini, 2015).

In the world, given the constant exploitation of raw materials, basic and essential materials for the production of cement such as clay and limestone are in short supply since the exploitation is indiscriminate and does not measure the consequences, causing great damage to the environment.

The needs of the market, concerning the characteristics and performance of building materials, have been developing multiple investigations, with a focus on the main binder such as Portland cement; from an industrial and laboratory point of view, seeking the improvement of its mechanical characteristics (Osorio, 2018).

The need to achieve the optimization of cement design and concrete production is focused on its main constituent, silica, representing approximately 20% of the total (Valdivia et al, 2010).

Materials and Methods

The type of research is basic, with a descriptive design. The mollusks were obtained from the beaches of the city of Chimbote, in their natural state and presented many impurities of organic character for which it was necessary to remove all the material of the interior and the external algae, through an initial washing.

Figure 1. Fan-shell mollusk in the natural state previously cleaned.

After this, it was placed on a filter paper and the best samples were selected, which were dried at room temperature for a period of 24 hours.

In the dry state, it was taken to the muffle for thermal activation at 1000° C. for a period of 1h and 30.

Figure 2. Molluscan fan-shell mollusk in before entering the muffle.

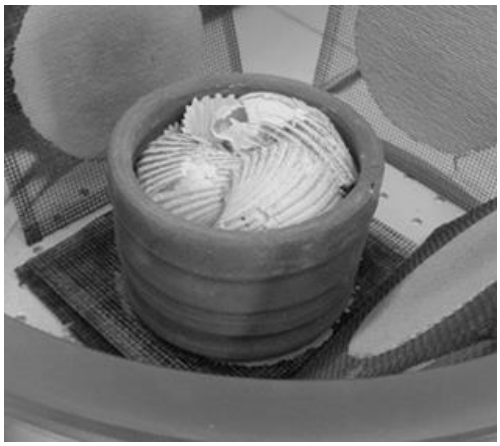

Figure 3. Fan-shell mollusk after removal from the muffle.

After that, the sample was placed in a dryer to reduce the temperature and it was weighed to calculate After this process, it was mechanically activated with the help of a mortar and sieved through a 200 mesh sieve until a particle size of 76 µm was obtained.

Figure 4. Mollusk calcined fan shell, crushed and sieved through a mesh screen # 200

The Shimadzu EDX 800 HS X-ray fluorescence spectrometer was used for the Pata de Mula sample. The temperature was 22.0 ° and the relative humidity was 68%.

A scanning microscope with energy dispersive spectrometry SEM-EMS probe, CarlsZeiss EVO-10 MA/EDS probe, and Oxford X-Max, was used for the snail sample. The temperature was 25.0 ° and the relative humidity was 62%.

Shimadzu X-ray fluorescence spectrometer, EDX 800 HS, was used for the analysis of the fan shells. The temperature was 23.0 ° and the relative humidity was 61%.

Results and Discussion

Table 1: Chemical composition of mule's foot mollusks

Chemical Composition	Result %	Method used
Calcium oxide (CaO)	99.627	Spectrometry of Ray Fluorescence X
Sulfur trioxide (SO_3)	0,195	
Chloride (Cl)	0.093	
Iron trioxide (Fe_2O_3)	0.083	

Table 1 shows the chemical composition of the mule's foot mollusk, which has a high percentage of calcium oxide (99.627%), which is the main component of cement, as indicated by Valdivia and Valdivia, that materials found in nature or from chemical processes and industry are used to make

cement. The production of cement requires a series of base materials such as rocks and soils with the following composition: CaO, SiO2, Al2O3, and Fe2O3 (lime, silica, alumina and iron oxides) (European Commission, 2010)

Table 2: Chemical composition of snail mollusks

Chemical composition	Result %	Method used
Calcium oxide (CaO)	99.5478	Energy dispersive spectroscopy (EDS)
Silicon dioxide(SO_2)	0.3503	
Magnesium oxide(MgO)	0.0946	
Iron trioxide (Fe_2O_3)	0.0186	
Barium oxide (BaO)	0.0180	
Zinc oxide (ZnO)	0.0065	
Lead dioxide (PbO_2)	0.0047	
dichromium trioxide (Cr_2O_3)	0.0021	
Manganese oxide (MnO)	0.0011	
Sulfur trioxide (SO_3)	0.0007	
Copper oxide (CuO)	0.0005	

Table 02 shows that the main chemical component of snail is calcium oxide (99.5479), which agrees with Bolognini, Martinez and Troconis, who indicate that the high and low contents of aluminum oxide and calcium oxide are very important in the cements that have been evaluated (Bolognini, 2015)

Table 3. Chemical composition of fan-shell mollusks

Chemical composition	Result %	Method used
Chemical composition	Result %	Method used
Calcium oxide (CaO)	80.755	X-ray fluorescence spectrometry
Sulfur oxide (SO_3)	12.044	
Phosphorus oxide (P_2O_5)	4.405	
Silicon oxide (SiO_2)	1.583	
Strontium oxide (Sr O)	0.771	
Iron oxide (Fe_2O_3)	0.442	

Table 3 shows the presence of 80.755% calcium oxide and 12.044% sulfur oxide in the chemical composition of the fan shell, which is the main component of cement. 044% in its chemical composition of the fan shell, which is the main component of cement as indicated by the European Commission, the first step in the production of cement is to calcine the calcium carbonate, continuing with the reactions of calcium oxide together with silica, alumina and iron oxide 11 and finding that according to Galván and Velásquez the presence of sulfur, which is not a common compound of the basic materials, is considered a polluting material (Galvan, 2011).

Table 4. Chemical composition of cement

Chemical composition	**Result %**	**Method used**
Silicon dioxide (SiO_2)	19.50%	X-ray fluorescence spectrometry
Aluminum oxide (Al_2O_3)	5.00%	
Iron trioxide (Fe_2O_3)	3.50%	
Calcium oxide (CaO)	60.00%	
Magnesium oxide (MgO)	1.00%	
Sulfur Trioxide	2.00%	
($S O_3$)	2.00%	
manganic oxide ($Mn2O_3$)	0.40%	
Titanium dioxide (TiO_2)	1.20 %	

According to table 04, it is possible to observe that the main component of cement is calcium oxide (60.00%), silicon dioxide (19.50%) and aluminum oxide (5.00%) and compared with Tables 1, 2 and 3, it can be seen that mollusks such as mule's foot, snail and fan shell have high percentages of calcium oxide, the main component of cement as indicated by Porrero who indicates that values between 60% and 67% CaO for Portland cement type I of excellent quality (Porrero, 2004)-

Conclusions

The main component of the mule's foot mollusk has a high percentage of calcium oxide (99.627%). The main chemical composition of the snail shell was calcium oxide (99.5479). Fan shell had within its composition calcium oxide in 80.755 % and sulfur oxide in 12.044%. The cement is composed of a great percentage of calcium oxide (60.00%), silicon dioxide (19.50%) and aluminum oxide (5.00%) which can be replaced by the mollusks studied in this research, but it requires a previous treatment to add the other components of the cement so that it does not lose its properties.

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