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The Effect of Drying Time of Pearl Shells (*Pinctada penguin)* on Nutrition and Mineral Quality in the Strait of Buton

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Abstract

Pearl shells were one of the mineral sources for ruminant and non-ruminant animal feed. Several studies on pearl shells present results of different nutritional and mineral content caused by several factors, including the geographical location of an area and the processing process. The purpose of this study was to determine the effect of different drying times on the quality of the Nutrient and Mineral content of the *Pinctada penguin* shells in the Buton Strait. The research design used was a completely randomized design with four treatments and four replications, each replication consisting of 400 grams of Pinctada penguin. The research sample was dried at 120^0C for 15, 30, and 45 minutes for each treatment. Then an analysis was carried out to see the levels of calcium (Ca), Iron (Fe), Zinc (Zn), Protein, Fat, Phosphorus (P), Potassium (K), and Iodine (I). The research data were analyzed using analysis of variance (ANOVA) based on RAL using the SPSS standard. If the treatment has a significant effect, further tests are carried out with the Duncan Multiple Range Test.

Keywords: pearl shell, drying time, nutrient content.

A. Introduction

The waters in the Buton Strait had been potential in cultivating *Pinctada penguin* pearl shells. Pearl shells were a leading commodity in Palabusa Village, District. Lea-lea, District. The smells produce as much as ± 400 kg of shellfish waste each year. The content in shellfish flour is calcium protein and phosphorus, which were needed by livestock to grow, develop, and reproduce.

Pearl shells were a source of minerals for animal feed. Minerals were needed for the manufacture of ruminant and non-ruminant animal feed. The minerals contained in pearl shells reach 31,100 mg/kg calcium (Ca). In general, the composition of pearl oyster shells consists of Mg, Na, P, and other minerals in Fe, Cu, Ni, B, Zn, and Si. The calcium carbonate content in this

shell was a source of calcium that can be used as Hydroxyapatite Agustini *et al*. (2011). Utilization of shells waste as a mineral source has been widely carried out, among others; Shah *et al*. (2014) said that the high content of calcium carbonate in clamshells could be used in drug formulations and construction. However, according to John (2016), oyster shell flour, Crassostreamadrasensis, can effectively be used in the pharmaceutical, fertilizer, lime, cement, and poultry feed industries, while Mahary (2017) uses blood clam flour as a source of calcium in catfish feed. Furthermore, Yoa *et al*. (2014) reported that the chemical analysis of shellfish showed that the bioavailability of calcium from shells was higher than calcium salts. They were used in allopathic medicine, and the main elements of calcium, magnesium, and sodium are very important for health.

The purpose of this study was to determine the effect of different drying times on the quality of the nutrient and mineral content in the shells of Pinctada penguins in the Buton Strait.

B. Methodology

1. Research Design

The research used a Completely Randomized Design with four treatments and four replications, each consisting of 400 grams of *Pinctada penguin* pearl shell flour.

The arrangement of the experiments that have been carried out was as follows:

P0 = Drying clamshells using sunlight
P1 = Drying of clam shells at a temperature of 120^0C During 15 minutes
P2 = Drying of clam shells at a temperature of 120^0C During 30 minutes
P3 = Drying of clam shells at a temperature of 120^0C During 45 minutes

2. Procedure of Research

The sample used in this study was the *Pinctada penguin* pearl shell. The *Pinctada penguin* pearl shell will first be cleaned of adhering dirt using clear water. After cleaning, the *Pinctada penguin* pearl scallop shells will be sun-dried for 6 hours. Then, after drying, the pearl oyster shells will be broken into small granules using a mortar. *Pinctada penguin* pearl oyster shells were then dried at 120^0C. The length of time used for Drying depends on the research treatment. After carrying out the drying process with several treatments, the pearl oyster shell grains will be mashed using a mortar. After being mashed, the pearl oyster shells will be analyzed for the nutritional and mineral content contained therein.

3. Parameters of Research

The parameters studied in this study were calcium (ca), phosphorus (p), potassium (k), iron (Fe), zinc (Zn), iodine (i), protein, crude fiber, and fat.

4. Data Analysis

The mathematical model was as follows:

$$Yij = \mu + \alpha i + \varepsilon ij$$

Wherein:

Yij = observational value of the i-th treatment and j repetition
μ = average value of observations
αi = the effect of treatment i
εij = th try error–i

The data obtained were processed using a completely randomized design. If the treatment has a significant effect, further tests were carried out with the Duncan Multiple Range Test.

C. Result and Discussion

1. Calcium (Ca)

Calcium (Ca) content was the amount of calcium (Ca) contained in raw materials expressed in percent (%). The average percentage of calcium (Ca) obtained was presented in Table 1.

Based on the results of analysis of variance showed that the quality of calcium (Ca) levels of *Pinctada penguin* pearl oyster shells which were treated with different drying times, gave a significant effect ($P<0.05$).

Table.1 Calcium (Ca) Content Of *Pinctada penguin* Pearl Oyster Shells With Different Drying Times.

Test	Treatment			
	P0 (Control)	P1 (15 Minutes)	P2 (30 Minutes)	P3 (45 Minutes)
1	26.58	28.39	30.71	32.36
2	28.93	29.18	30.36	32.43
3	27.61	28.97	29.79	31.89
4	26.54	29.59	31.73	32.36
Average	27.42±1000[a]	29.03±1000[b]	30.65±1000[c]	32.26±1000[d]

Description: Numbers followed by different letter superscripts in the same row and column show a very significant effect (P<0.05).

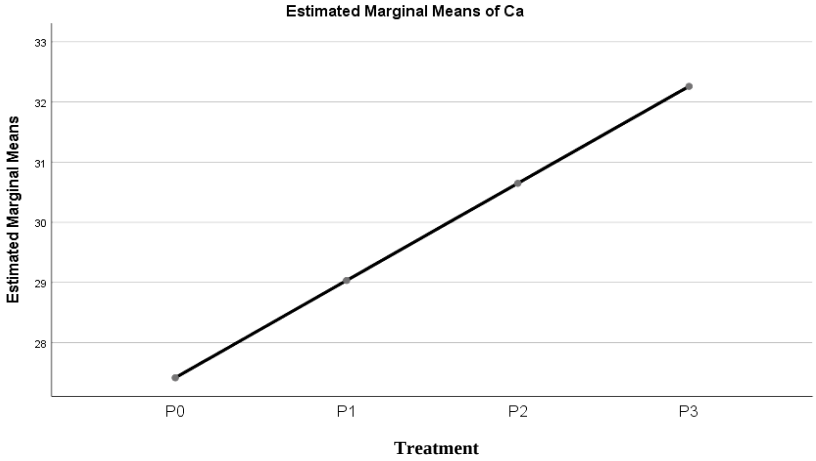

Figure 1. Graph of Calcium (Ca) Levels of Pearl Oyster Shells

Figure 1. Shows pearl oyster shells with different drying times significantly affect the quality of calcium (Ca), where (P0) was controlled and increased at P1, P2, and P3. Based on the results of the average percentage of research in Table 1, the average value of calcium (Ca) levels ranges between (27.42 - 32.26 %). Calcium (Ca) levels in P1 (29.03%), P2 (30.65%), and P3 increased by 32.26%, greater than the results of research by Kalesaran *et al.* (2018) with an average value (31, 10%) This has a good impact on the need for calcium for animal feed by utilizing waste can so that it can be of economic value.

This study indicated that the longer the drying time of pearl oyster shell flour, the better the calcium mineral content. In other words, the calcium mineral content in pearl oyster shells was a mineral in large quantities, and this was because the shells were composed mostly of calcium carbonate. According to Apriliyanti (2010), drying time using high temperatures can cause changes in food ingredients. In addition, Southgate & Lucas (2008) added that the shell consists of about 95% calcium carbonate. Namelycalcite and aragonite, a form of biomineral composed of calcium carbonate (CaCO3) and a small amount of organic matrix protein. The use of clam shells as a source of mineral feed for livestock has good potential due to the shells' high calcium (Ca) content. The mineral content of calcium (Ca) in clamshells ranges from 29-37%, while the content of phosphorus (P) was 0.13-0.33% (Wardhani, 2009).

The use of clamshells for animal feed can be processed into flour through a direct milling process or burning. Processing of shells with the milling method has the advantage of easier processing and can be made in various forms such as coarse (grit) and fine (flour) mills. Shellfish shells in the form of grit are generally given to poultry because apart from being a source of minerals, grit can also help the digestive process in the gizzard.

2. Phosphor (P)

Phosphorus content (P) was the amount of phosphorus (P) contained in raw materials expressed in percent (%). The average percentage of phosphorus (P) obtained was presented in Table 2.

Based on the results of analysis of variance, it showed that the quality of Phosphorus Levels (P) of *Pinctada penguin* pearl conch shells treated with different drying times had no significant effect (P<0.05).

Table.2 Phosphorus Content (P) Of *Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	P1 (15 Minutes)	P2 (30 Minutes)	P3 (45 Minutes)
1	0.23	0.10	0.09	0.13
2	0.32	0.30	0.11	0.16
3	0.24	0.20	0.21	0.14
4	0.13	0.20	0.15	0.09
Average	0.23±1000[a]	0.20±1000[a]	0.14±1000[a]	0.13±1000[a]

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

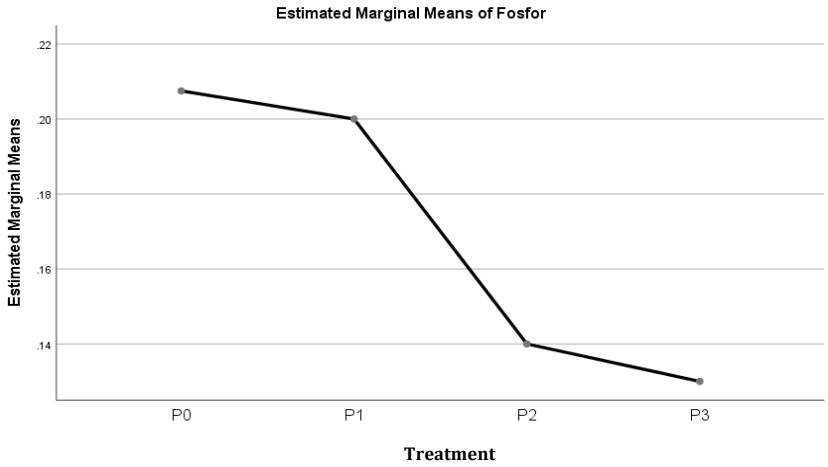

Figure 2. Phosphorus Content (P) Graph of Pearl Shells

Figure 2. Shows pearl oyster shells with different drying times don't significantly affect phosphorus quality (p). In other words, the longer the drying time is given, the lower the quality of phosphorus (P) in *Pinctada penguin* pearl shells. Based on the results of the average percentage of research in Table 2. Shows that the average value of phosphorus levels was at P0 (0.23%), P1 (0.20%), P2 (0.14%) and P3 (0.13%). Phosphorus acquisition results The results of the acquisition of phosphorus levels were calculated following the provisions of SNI 8290.5-2016. The results of the acquisition of phosphorus levels are not following SNI 8290.5-2016, which was a minimum of 0.55%. However, these results can cause the balance of calcium and phosphorus in chicken rations to vary in a fairly wide range without causing losses. However, if one of these elements is excessive, it can interfere with absorption from the digestive tract in livestock. The best balance of available calcium and phosphorus was 1.5:1 and 2:1 (Wahju, 2004).

Phosphorus (P) was an essential element for all life, a structural and functional component of all organisms. Phosphorus was an important component of bone, cartilage, and exoskeleton. Onoda & Nakanishi (2012) explained that phosphorus in clamshells was in the form of calcium phosphate. Calcium phosphate was an important material for ion exchangers, adsorbents, etc. Furthermore, it was explained that the need for calcium phosphate was increasing nowadays as a waste recycling material where clam shells had been used as raw materials for various purposes.

3. Potassium Content(K)

Potassium content (K) was the amount of potassium (K) contained in raw materials expressed in percent (%). The average percentage of potassium (K) obtained was presented in Table 3.

Based on the results of the analysis of variance, it was shown that the quality of Potassium content (K) of *Pinctada penguin* pearl shells which were treated with different drying times, had no significant effect (P<0.05).

Figure 3. Showed that pearl oyster shells with different drying times significantly affect the quality of potassium (K). Based on the results of the average percentage of research in Table 3. showed that the average value of potassium levels was at P0 (12.15%), P1 (13.26%), P2 (17.73%), and P3 (18.94%). The results of this study experienced a significant increase in P3

with an average value of P3 (18.94%) at drying 45 minutes. It indicated that the longer the drying time of the pearl oyster shells, the better the quality of the potassium content.

Table 3. Potassium (K) Content Of*Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	P1 (15 Minutes)	P2 (30 Minutes)	P3 (45 Minutes)
1	13.01	14.02	17.34	19.16
2	12.27	12.71	17.47	18.65
3	11.98	13.10	18.13	18.74
4	11.32	13.21	17.97	19.21
Average	12.15±1.000[a]	13.26±1.000[b]	17.73±1.000[c]	18.94±1.000[d]

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

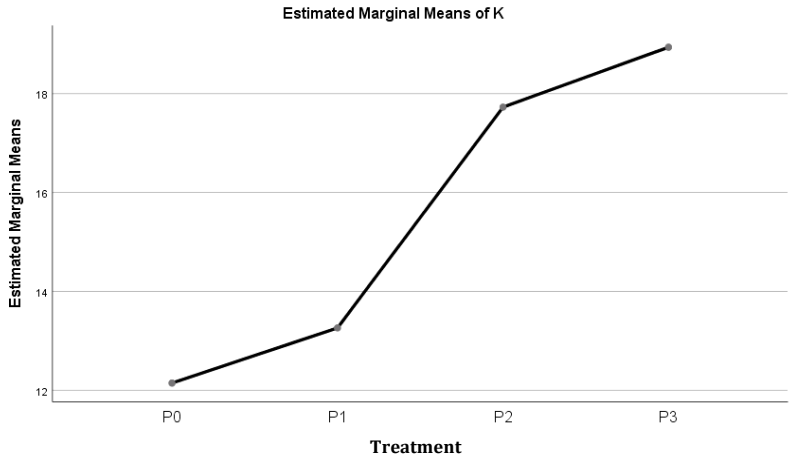

Figure 3. Graph of Potassium (K) Pearl Shell

The potassium content of pearl oyster shells increases because of water evaporation; the higher the temperature used, the more water molecules that come out (Winarno 2008). Mineral content such as potassium can change its chemical structure during the heating process or interactions with other materials. Mineral solubility may increase or decrease depending on the process. (Santoso *et al*., 2007).

4. Iron Content (Fe)

Iron (Fe) content was the amount of iron (Fe) contained in raw materials expressed in percent (%). The average percentage of iron (Fe) content obtained is presented in Table 4.

Table. 4 Iron (Fe) Content Of*Pinctada penguin* Pearl Oyster Shells With Different Drying Times.

Test	Perlakuan			
	P0 (Control)	P1 (15 Minutes)	P2 (30 Minutes)	P3 (45 Minutes)
1	4.03	4.02	5.13	4.96
2	3.76	3.48	4.41	4.83
3	2.79	3.87	4.57	5.14
4	3.86	3.61	4.86	4.94
Average	3.61±595[a]	3.75±595[a]	4.74±381[b]	4.97±381[b]

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

Based on the results of the analysis of variance, it showed that the quality of the Iron (Fe) content of *Pinctada penguin* pearl shells which were treated with different drying times, had no significant effect (P<0.05).

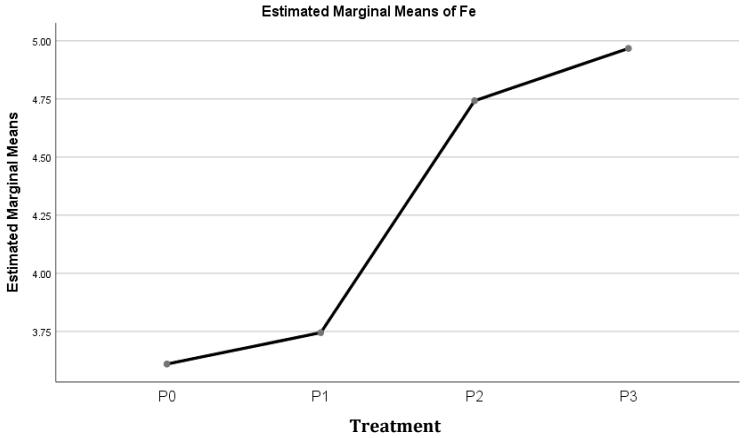

Figure 4. Graph of Iron (Fe) Content of Pearl Shells

Figure 4. Showed the pearl oyster shells with different drying times were significantly affected. The quality of iron (Fe). Based on the results of the average percentage of research in Table 4. showed that the average value of iron (Fe) at P0(3.61%), P1 (3.75%), P2(4.74%), and P3(4.97%). It showed that the longer the drying time of pearl oyster shells, the better the quality of iron (Fe). It was following research (Kalesaran *et al.,* 2018) with an average value of 3.00%. Winarno (2004) The increase in iron was thought to be caused by high temperatures. In addition, if the pH of the pearl shell increases, it would increase iron content (Yoshie *et al*., 1999). The iron (Fe) needed in livestock is 20-80 Mg/Kg, where it functions to transport oxygen from the lungs to all body tissues or in cells.

5. Zinc Content (Zn)

Zinc content (Zn) was the amount of zinc (Zn) contained in raw materials expressed in percent (%). The average percentage of zinc (Zn) obtained was presented in Table 5.

Table 5. Zinc (Zn) Content Of*Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	**P1 (15 Minutes)**	**P2 (30 Minutes)**	**P3 (45 Minutes)**
1	11.28	20.18	24.84	3.37
2	11.93	20.17	23.76	34.93
3	11.71	19.83	24.28	35.89
4	12.04	20.04	24.89	35.74
Average	11.74±1.000[a]	20.06±1.000[b]	24.44±1.000[c]	35.98±1.000[d]

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

Based on the results of the analysis of variance showed that the quality of zinc (Zn) levels of *Pinctada penguin* pearl oyster shells which were treated with different drying times, had a very significant effect (P<0.05).

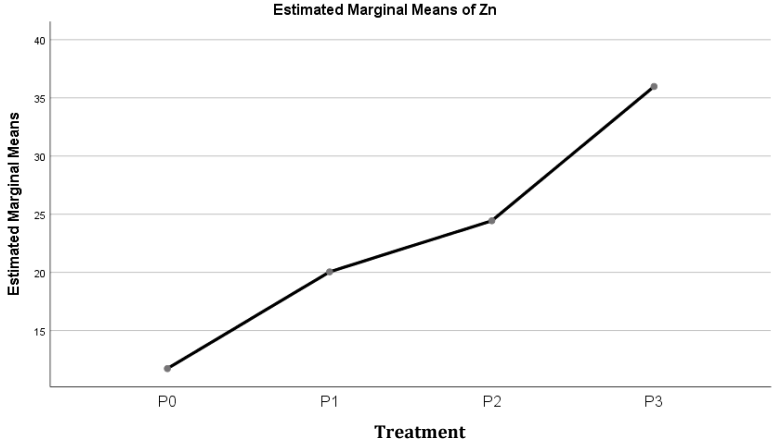

Figure 5. Graph of Zinc (Zn) Concentration of Pearl Shells

Figure 5. showed that the quality of zinc (Zn) has a significant effect (P<0.05). on different drying times with the results of the average percentage of research at P0 (11.74%), P1 (20.06%), P2 (424.44%) and P3 (35.98%) this shows that the longer the drying time pearl shells, the better the quality of the zinc (Zn) content. The results of this study experienced a significant increase in the P3 treatment, which average value was 35.98%, with a drying and oven time of 45 minutes at a temperature of 120^0C.

These results followed the statement of Almatsier (2009). That fishery products (shellfish) are the best source of zinc (Zn). Zinc deficiency in humans will cause short body characteristics and delays in sexual maturation and livestock. According to Santoso *et al*. (2007), differences in mineral content in aquatic organisms are generally influenced by the absorption of food from various substances suspended in the waters where they live. The ability of organisms to absorb various suspended substances was influenced by several factors, namely environmental conditions, organism size, species, pH, and starvation conditions of the organism. Yoshie *et al*. (1999) reported that the mineral content in an aquatic biota is influenced by the concentration of minerals in their habitat and the growth phase.

6. Iodine Content (I)

Iodine content (I) was the amount of Iodine (I) contained in raw materials expressed in percent (%). The average percentage of iodine content (I) obtained was presented in Table 6.

Table 6. Iodine Content (I) *Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	**P1 (15 Minutes)**	**P2 (30 Minutes)**	**P3 (45 Minutes)**
1	1.76	1.08	0.71	0.37
2	1.46	1.17	1.03	0.34
3	1.61	0.86	0.72	0.41
4	1.94	0.91	0.83	0.36
Average	1.69 ± 1.000^a	1.01 ± 1.000^b	0.83 ± 1.000^b	0.37 ± 1.000^c

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

Based on the results of the analysis of variance, it showed that the quality of the Iodine (I) content of *Pinctada penguin* pearl oyster shells that were treated with different drying times had no significant effect (P<0.05).

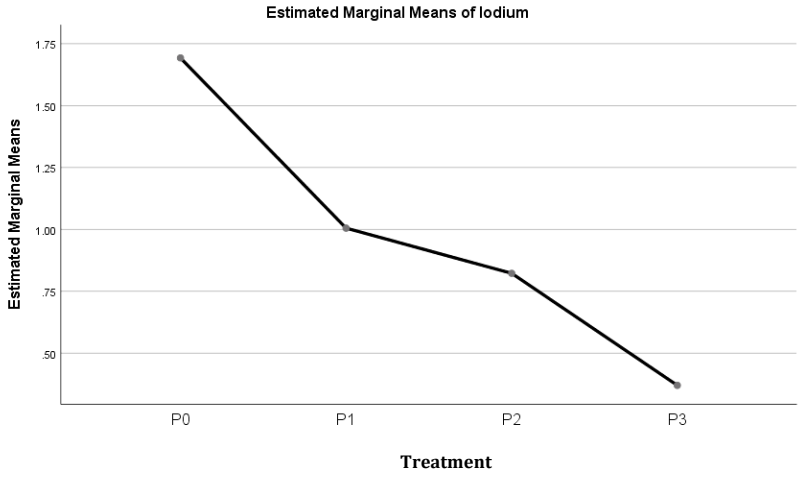

Figure 6. Graph of Iodine (I) Content Pearl oyster shell

Figure 6. Shows pearl oyster shells with different drying times that have no significant effect on the quality of Iodine (I). Based on the results of the average percentage of research in Table 6. Shows that the average value of Iodine (I) at P0 (1.69%), P1 (1.01%), P2 (0.82%) and P3 (0.37%). It showed that the longer the drying time of the pearl oyster shells, the lower the quality of Iodine (I) in the pearl oyster shells.

Iodine was an essential mineral constituent of the thyroxine hormone by the thyroid gland. This hormone regulates growth by stimulating metabolism in tissues, increasing consumption, and heat production (Tillman *et al*., 1988). The thyroid gland also influences

blood circulation and the metabolism of nutrients, including various minerals and water (Almatsier, 2009).

7. Protein Content

Protein content was the amount of protein contained in raw materials expressed in percent (%). The average percentage of protein content obtained is presented in Table 7.

Table 7. Protein Content Of*Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	**P1 (15 Minutes)**	**P2 (30 Minutes)**	**P3 (45 Minutes)**
1	14.46	16.18	16.94	16.92
2	15.41	15.47	17.87	17.57
3	14.43	15.97	18.65	17.43
4	15.59	16.09	18.18	17.23
Average	14.98±1000[a]	15.93±1000[b]	17.91±118[c]	17.29±118[c]

Description: Numbers followed by different superscript letters in the same row and column show a significant effect (P<0.05)

The analysis of variance showed that the quality of Pinctada penguin pearl oyster had shell protein levels treated with different drying times gave a significant effect (P<0.05).

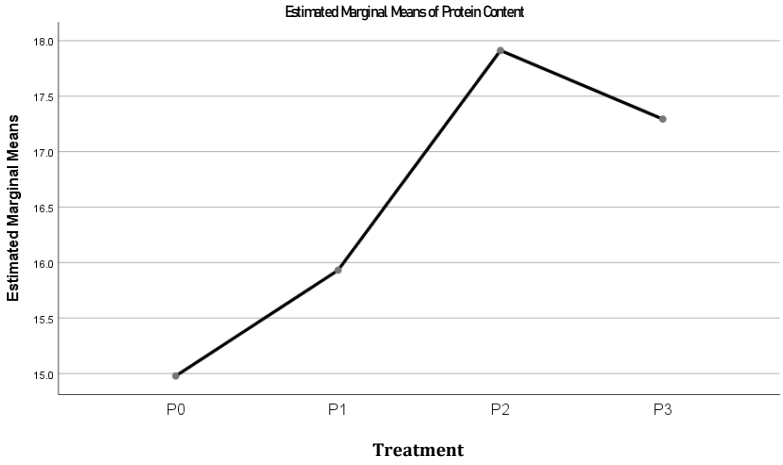

Figure 7. Graph of Pearl Shell Protein Content

Figure 7. showed that drying pearl oyster shells with different drying times had a significant effect. Where the control experiment (P0) only uses sunlight with a Protein value of 14.98%, P1 with an oven treatment for 15 minutes with a Protein value of 15.93 %, in treatment P2 experienced an increase from the previous treatment, namely 17.91% with drying for 30 minutes, in P3 there was a very significant decrease, namely 17.29%. The drying time in the P3 experiment was 45 minutes which caused a decrease in protein content.

Salamah *et al*. (2012) Explain that protein levels have decreased due to processing with high temperatures and a long time so that the protein content was denatured/damaged. The effect of boiling by boiling caused the decrease in protein levels in blood clams. Harris & Karman (1998) confirmed that the heating process reduces the nutritional value more than the steaming method. Apart from processing factors, the decrease in protein content was also caused by the characteristics of the protein. It was easily absorbed in activated carbon and heavy metals. De Man & John (1997) added that sarcoplasmic protein is the second-largest with water-soluble properties. The physical characteristics of the sarcoplasm were responsible for the high solubility of the sarcoplasm in water.

8. Fit Content

Fat content was the amount of fat in raw materials expressed in percent (%). The average percentage of protein content obtained is presented in Table 8.

The analysis of variance showed that the quality of the fat content of Pinctada penguin pearl shells treated with different drying times didn't have a significant effect (P<0.05).

Table. 8. Fat Content Of *Pinctada penguin* Pearl Oyster Shells With Different Drying Times

Test	Treatment			
	P0 (Control)	P1 (15 Minutes)	P2 (30 Minutes)	P3 (45 Minutes)
1	2.41	2.63	2.84	2.74
2	1.98	3.04	2.64	2.85
3	2.58	2.21	2.48	2.54
4	2.46	2.38	2.73	2.62
Average	**2.36±1000[a]**	**2.57±1000[b]**	**2.67±118[c]**	**2.69±118[c]**

Description: Numbers followed by different superscript letters in the same row and column significantly affect (P<0.05).

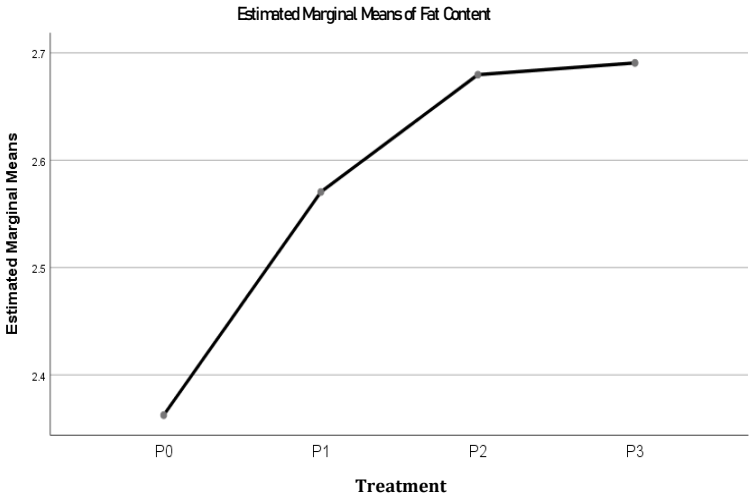

Figure 8. Graph of Pearl Shells Fat Content

Figure 8. Showed pearl oyster shells with different drying times that significantly affect fat quality. Based on the results of the average percentage of research in Table 8. showed that the average value of fat is at P0 (2.36%), P1 (2.57%), P2 (2.67%), and P3 (2.69%) indicates that. The longer the drying time, the better the fat quality on the pearl shells.

This study showed the highest fat content at P3 with an average value (2.69%) drying time of 45 minutes. It indicated the high-fat content in pearl oyster shells. High-fat content was following research conducted by Ashuri *et al.* (2021). The results of a study of 18.11% fat content of clamshells with temperature and smoking time will affect fat content; low temperature not too long smoking time can cause high-fat content—high fat. The high-fat content can also be caused by the reaction between heat and the attachment of liquid smoke components that react with enzymes in fish tissue, thereby increasing the rate of change in fat content.

D. Conclusion

Based on the results of research that has been carried out. Pinctada penuin pearl shell with different drying times has a significant effect (P<0.05) on the content of calcium (Ca), iron (Fe), zinc (Zn), protein, and fat. It did not significantly affect the nutritional content of phosphorus (p), potassium (k), and Iodine (i).

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