

Research Article

**Physico-chemical Properties, Microbial Analyses and Acceptability of Fern
(*Diplazium esculentum* (Retz.) Sw.) Pesto**

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ABSTRACT

The vegetable fern plant (*Diplazium esculentum* (Retz.) Sw.), locally known as “pako” in Besigan, Cagayan de Oro City, is a good source of nutrients which, an ample of serving of this vegetable fern in a meal, would help alleviate nutrient-related problems. Fiddlehead fern is often listed among the several kinds of edible ferns mostly found in the different places in the Philippines and other tropical countries in Asia, such as Indonesia, India, China, Japan, Thailand and even in North America, Hawaii and some parts of Australia. This vegetable fern which is usually found in gravel bars, bank of streams, rivers, freshwater swamps or in the wilds, is often sold in bunch in local markets at a cheaper price and can be eaten cooked or raw.

The purpose of this study was to use fiddlehead fern as an alternative ingredient for basil in making pesto and to enhance its health benefits. The fern pesto product was tested by F.A.S.T. Laboratories, for nutrient content, physico-chemical properties and microbial analyses. For sensory evaluation, the 9-point Hedonic Scale was used.

This study found that fern pesto is a good source of nutrients such as crude protein, % (9.65), calcium, % (0.12), iron, mg/kg (15.51) and potassium, % (0.24). The result indicated that the nutrient of fern pesto is comparable to basic pesto made and basil pesto in the literature. The results of the physico-chemical analyses showed a pH level of 5.47 and moisture content of 30.11. This means that the fern pesto is slightly acidic and had a high moisture content that required storing it at lower temperature to delay any microbial and chemical reactions. The present study also showed that the average results of microbial count for total plate count, cfu/g (1.347×10^4) and yeast and mold count, cfu/g (300) are both lower than the standard TPC (10^6) and YMC (10^4) for sauces. The fern pesto has negative result in Salmonella which is an indication that hygienic preparation and proper handling of the product were observed. For sensory evaluation, it was rated “*Like moderately*” (6.5-7.4) in all parameters tested. The result implies that the panellists highly preferred fern pesto over basic pesto.

Key words: fiddlehead fern, nutrient content, physicochemical, microbial analyses, sensory evaluation, fern pesto

I. Background

Aboriginal plants play a crucial role in the economic and social spheres of every locality. Besigan, the farthest barangay of Cagayan de Oro City with approximately 60 kilometres distance from the city, has an ample existence of diverse species of plants, but as yet remained

understudied. Some of these indigenous species of plants are used by the community for their living. Fiddlehead fern (*Diplazium esculentum* (Retz.) Sw.), known locally as “Pako”, is a very popular specie of vegetable fern plant that grows abundantly in Besigan due to its humidity and wet

season. It is usually prepared as salad, a ingredient in “*ginataan*” pako(cooked in coconut milk) and other vegetable dishes. The vegetable fern can be eaten raw or cooked. If the latter is preferred, it is ideal to soak it for a few minutes in boiling water, or to cook it directly to remove the bitter taste. The vegetable fern is a good source of vitamin A, vitamin B, protein, phosphorus, calcium and iron. These promising health benefits coming from this vegetable fern has an essential role in preventing nutrient deficiencies and health-related problems. The goal of this research study was to innovate and create a nutritionally superior pesto product out of fiddlehead fern that would be widely accepted based on its nutritional, visual and textual appeal.

II. MATERIALS AND METHODS

Research Design

The experimental method of research was used in conducting this study, which included the process flow of fern pesto product, sampling scheme, sensory evaluation and nutritional content, physico-chemical properties and microbial analyses.

Research Setting

This study was conducted at Mindanao University of Science and Technology (formerly, Mindanao Polytechnic State College), C.M. Recto Avenue, Lapasan, Cagayan de Oro City. The experiments and preparation of the product testing was performed in the Culinary Arts Laboratory of the university. The sample was subjected for nutritional content analysis, physico-chemical and microbial analyses in the F.A.S.T. Laboratories, located at Lapasan Highway, Cagayan de Oro City. For sensory evaluation, one hundred consumers evaluated the fern pesto product. The Hedonic Scale Test was used in determining the acceptability of the product.

The source of fiddlehead fern used in this study was from Besigan, Cagayan de Oro City. The supplies and materials of fern pesto product were secured at Cogon Market, Robinsons, Rustans,

and Gaisano Mall, all located in Cagayan de Oro City.

Preparation of the Sample

The recipe used for this experiment is patterned from a basic recipe for making pesto. It was modified by replacing grams of basil leaves with fiddlehead fern. Prior to the selection of fern pesto recipe, three trials of recipe which varied in percentage of added fiddlehead fern was conducted. It was then evaluated by five teachers who decided that 80g of fiddlehead fern was ideal for pesto making.

In making pesto, it is very essential to practice high hygienic procedures and follow the correct processes. After sorting the fern vegetable, the fern was blanched in order to clean the surface of dirt and organisms and to brighten the color of the fern. In making the fern pesto sample, 20 g of basil leaves was used, with 4 g chopped garlic, 100 g grated parmesan cheese, 75 g pine nuts, 125 ml olive oil, 1 tsp. salt, ½ tsp. black pepper and 1 tsp. American lemon to enhance the taste. All ingredients were measured according to the proposed requirement and were combined with the used of food processor. Finally, the nutritional content, physico-chemical, microbial analyses and sensory evaluation of the prepared samples were done.

Analysis of Nutritional Content

The average of the nutritional content during the three sampling periods conducted was the basis for comparing the percent difference of calcium, iron, crude protein and potassium between fern and basic pesto.

Physico-chemical Properties

The average of the physical properties from the sampling periods conducted was the basis for comparing the percent difference of moisture content and pH level of fern and basic pesto.

Microbial Analyses

The average result of Total Plate Count (TPC) and Yeast and Mold Count (YMC) from the sampling periods was the basis for comparing it to the average standard count for TPC and YMC of fern and basic pesto. On the other hand, the consistent

negative result of Salmonella of both fern and basic pesto was the basis for the hygienic procedures and sanitation observed during food preparation.

Sensory Evaluation

The 9-point Hedonic Scale was used to evaluate the sensory quality of basic and fern pesto

products. The appearance, color, aroma and flavor, mouth feel and taste are the sensory qualities used in determining the acceptability of the innovated pesto product. The respondents, who evaluated the pesto product were composed of 20 teachers, 5 industry workers and 75 students, a total of 100 consumers.

III. RESULTS AND DISCUSSIONS

Findings : Problem No.1. What are the nutrient content, physical properties, microbial analyses and acceptability level of basic pesto and fern pesto?

Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1 st Sample 12 July – 12 Aug. 2016	Crude Protein, % (%N x 6.25)	Kjeldahl	10.25	9.65
2 nd Sample 26 July – 15 Aug. 2016	^c Calcium, mg/Kg	Atomic Absorption Spectrophotometry	0.18	0.12
3 rd Sample 4 Aug. – 18 Aug. 2016	Iron, mg/Kg	Atomic Absorption Spectrophotometry	16.20	15.57
	Potassium, %	Atomic Absorption Spectrophotometry	0.25	0.24

Table 1.1 The Average Values of Nutritional Content of Pesto

The table above shows the average nutritional content of pesto. Result indicates that the nutrient content of the two types of pesto is quite similar and is comparable with the nutrient content for basil pesto in the literature. The small difference in the nutrient content of experimental basil pesto and with the literature might be due to some varietal or origin of the raw materials. During the preparation of the fern pesto, the fern was subjected to blanching which might be the cause for nutrient loss. Moreover, different literature for basil pesto differs in the nutrition facts.

Table 1.2 The Average Values of Physico-chemical Properties of Pesto

Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1 st Sample 12 July – 12 Aug. 2016	pH	4500 H ⁺ B. Electrometry	5.20	5.47
2 nd Sample 26 July – 15 Aug. 2016	^c Moisture, %	Vacuum Oven Drying	26.15	30.11
3 rd Sample 4 Aug. – 18 Aug. 2016				

Source: F.A.S.T. Laboratories, Cagayan de Oro City, Misamis Oriental

The pH value and moisture content of both pesto is presented in Table 1.2. The results show that that pH of both pesto is slightly acidic with pH 5.20 for basic and 5.47 for fern pesto ,respectively, Moreover, the

moisture content of basic pesto is 26.15% compared to fern pesto with 30.11%. The higher moisture content of the sample indicates a non-stable product and must be stored in lower temperature to delay any microbial and chemical reactions.

Table 1.3 The Average Microbial Count and Presence and Absence of Salmonella in Pesto Results

Date of Analysis	Parameters	Test Method	Basic Pesto	Fern Pesto
1 st Sample 12 July – 12 Aug. 2016	Total Plate Count, CFU/g	Pour Plate	1.06×10^4	1.347×10^4
2 nd Sample 26 July – 15 Aug. 2016	Yeast and Mold Count CFU/g	Spread Plate	53.33	300.00
3 rd Sample 4 Aug. – 18 Aug. 2016	Salmonella	Conventional	Negative	Negative

Source: F.A.S.T. Laboratories, Cagayan de Oro City, Misamis Oriental

Table 1.3 shows the average total plate count (cfu/g) and yeast and mold count (cfu/g) of the two pesto samples as well as the standard limit for sauces. The results indicate that total plate count is 1.06×10^4 and 1.347×10^4 for basic and fern pesto, respectively, which is lower than the 10^6 standard for sauces. In addition, the yeast and mold count is 53.33 and 300 for basic and fern pesto, respectively. This is also lower than the 10^4 standard for sauces. Both products are also negative for Salmonella, which means that in the preparation of the product, hygienic procedures and practices were observed. This implies that hygiene and sanitation were observed in the preparation and handling of the product.

Table 1.4 Mean Values of the Acceptability Level of Pesto

Sensory Quality	Types of Pesto (Sample)			
	Basic	Remarks	Fern	Remarks
Appearance	6.17	LS	6.78	LM
Color	5.82	LS	6.58	LM
Aroma	6.00	LS	6.65	LM
Mouth feel	6.03	LS	6.56	LM
Taste	6.09	LS	6.68	LM

Legend: LS – Like Slightly, LM – Like Moderately

The mean values for the acceptability of the two pesto are presented in Table 5. Result shows that basic pesto is rated by the panelist as “*Like slightly*” (ratings 5.5 – 6.4) while fern pesto was rated as “*Like moderately*” (ratings 6.5 – 7.4). In all the sensory parameters tested, the result indicated a higher preference of the panelist for fern pesto over basic pesto.

The strong aroma and flavor of the basic pesto could have affected, the consumer’s acceptance since usually they form an opinion based on the initial dark green color appearance and the strong aroma of the basic pesto. Table 1.4 shows fern pesto is acceptable based on visual sensation, light green color, mild aroma, sensory impression, natural flavor, and soft quality. Its unique and neutral taste as evident on the freshness of the ingredients is recognized and preferred by the consumers.

Problem No.2. Is there a significant difference between basic pesto and fern pesto in terms of nutritional contents, physical properties, microbial analyses and acceptability?

Table 2.1 Calculated t-values for the Nutritional Content of Pesto

Nutrients	t – value	^t tab
Crude Protein, %	0.61	2.78
Calcium, %	1.48	
Iron, mg/kg	0.21	
Potassium, %	0.66	

Calculated t-values for the nutritional content of pesto are presented in Table 2.1 The calculated t-values are lesser than the tabular t-value which implies that the samples are not significantly different in their nutritional content. The result indicates that fern pesto is comparable to the standard pesto in terms of its nutritional content. Fern can therefore be a good source of nutrients when processed into pesto.

Table 2.2 Calculated t-value for the Physico-chemical Properties of Pesto

Physical Properties	t – value	^t tab
pH	-2.57	2.78
Moisture , %	-1.86	

The table above shows that the pH and moisture content of the two samples do not differ significantly as reflected by a lower calculated t than the tabular t. This simply means that the fern pesto was comparable in terms of its pH and moisture count with the standard pesto.

Table 2.3 Calculated t-value for the Microbial Content of Pesto

Microbial Content	t – value	^t tab
Total Plate Count,CFU/g	0.45	2.78
Yeast and Mold Count, CFU/g	1.10	

Table 2.3 presents the t-value for microbial content of pesto. The results show a non-significant difference in both the total plate count and yeast and mold count of the two samples. Moreover, the total plate count and yeast and mold count results are lower than the standard limit for pesto which is 10^6 and 10^4 for total plate count and yeast and mold count, respectively.

Table 2.4 Calculated z-value of the Acceptability of Pesto

Sensory Quality	z – value	^z tab
Appearance	3.53	1.96
Color	3.49	
Aroma	3.86	
Mouth feel	2.70	
Taste	2.79	

Table 2.4 shows the calculated z-value for the acceptability of pesto in different sensory qualities. The results show that the calculated z-value is greater than the tabular z-value for all sensory qualities. The results indicate a significant difference in the acceptability of basic and fern pesto in all the sensory attributes tested, which means that fern pesto was more acceptable than

basic pesto in all the sensory attributes tested as indicated by a higher mean values than basic pesto.

IV. Conclusion

Based on the results, the following conclusions are drawn;

The nutrient content found in fern pesto may qualify for the Recommended Daily Allowance (RDA) of an individual by including it in a menu plan. The fern pesto nutrients such as crude protein, calcium, iron and potassium are minerals that are essential for maintaining the body structure and also responsible for making it healthy and strong. The percentage of those nutrients taken from fern pesto could supply the minimum requirement needed by the body.

The average acidity level and moisture content present on the fern pesto product signified that it could be stored for a period of time provided that time-temperature would be observed. The pesto product had good results in microbial analyses. It simply proved that the product is safe for the consumers. Hygienic procedures, consideration of external factors in production like its exposure, time and temperature and appropriate containers for the product was strictly observed. However, the fern pesto product must be recommended for a shelf-life test to determine whether the product is ideal for mass production.

Together with these, the acceptability of the fern pesto in terms of appearance, color, aroma and flavor, mouth feel and taste was moderately like by the panellists.

V. Recommendations:

In view of the findings and conclusions, the following recommendations are suggested:

1. Fern pesto is recommended to homemakers for its nutritional content and minerals like crude protein, calcium, iron and potassium which met the recommended daily intake for children and adults, as well as, for health-conscious people.
2. Entrepreneurs like culinary practitioners and food industry may consider fern pesto for business and income generation. Promotion of this unique food innovation is recommended considering its high nutritional values and varied applications in meal planning.
3. The following factors for preserved food product should be strictly observed: hygienic

procedures and external factors in production like its exposure, time, temperature, and appropriate container for the product.

4. The shelf-life of fern pesto should also be studied to determine whether the product is ideal for mass production.
5. Further research should be undertaken considering full utilization of fiddlehead fern as alternative to basil pesto production, and more in-depth evaluation and analysis of nutritional content, physical properties, and microbial presence, as well as, acceptability level of fern pesto.

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