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DEVELOPING ALTERNATIVE PROTOCOL IN PILI (*Canarium ovatum Engl.*) PULP OIL ISOLATION

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Abstract — The study focused on the development of alternative protocol for isolating oil from pili (*Canarium ovatum*) pulp. It looked into essential aspects of pili pulp oil isolation by investigating existing protocol being employed by pili processors such as the traditional method, DOST recommended methods, and enzymatic extraction. Determining an alternative oil isolation protocol was conducted employing description matrix analysis based on the features of each of the existing protocol.

The proposed Ramirez Alternative Protocol RPOIM (Ramirez Pili Oil Isolation Method) consists of three major processes such as extraction and fractionation, oil isolation, and oil recovery. Fermentation of pulp for 1-2 days after mechanized mixing and after extraction is a distinct feature of the newly developed method. It was pilot tested using pili pulp samples from Bicol pili varieties obtained from the Department of Agriculture Regional Office V. Results confirmed the presence of oil in pili pulp as indicated by the data obtained on the percent oil yield of the samples tested such as 35.5% for Goa variety, 11.3% for Lanuza, 3.31% for Penafrancia, 9.76% for Magnaye and 25.2% for Laysa . It likewise revealed the potential of the RPOIM as alternative protocol to be used in pili pulp oil isolation.

Keywords — **Alternative protocol, oil isolation protocol, *Canarium ovatum,* pulp, pili pulp oil.**

INTRODUCTION

Pili (*Canarium ovatum Engl.*) is one of the indigenous fruit trees in the Philippines that has great potential for development (Briones, 2002). It is widely grown in the Bicol region, or even cultivated as a backyard crop. It can be propagated by seeds, but asexual method of propagation is highly recommended for the multiplication of high-yielding mother trees.

Pili is considered a tree of hope (BCAARD, 2010) because of its many uses. Kernel as the most important part, all the other parts were also noted to produce viable products. More than ten (10) food items can be prepared from the kernel. It is rich in nutrients, containing protein, carbohydrates, and oil which is aflatoxin-free and low in free fatty acids (Business Diary, 2019). It is also a source of edible oil of excellent quality that is being used in pharmaceutical and cosmetic products and for salad dressings. The pulp is used as a nutritious food delicacy and is processed into some useful products such as oil, food, and feeds. Pili shells are made into fashionable handicraft items. The tree is suited for reforestation because it makes an excellent windbreak. Its bark is tapped for its resin which is noted to be an excellent source of elemi oil, varnish, lacquer, and adhesives.

Pili is a priority commodity in the Bicol Region. It is one of the region's major products aside from coconut and abaca. A lot of researches had been conducted on the production, management, as well as the product development of pili which yielded a lot of benefits to the Bicolano farmers and entrepreneurs. Being able to further explore the pili potentials will be a promising initiative that can help alleviate the economic status of the region. This research on pulp oil isolation of pili will surely contribute knowledge on the utilization of this important resource.

The presence of oil from pili pulp has long been known. Many uses were associated with pili pulp oil in nutraceuticals and food industries (Pham and Dumandan, 2015). It was found to contain high quantities of unsaponifiable matter that contains lipid molecular species such as carotenoids and tocopherols. The potentials of the oil in the production of cosmetic products are also established due to the presence of tocopherols which are among the compounds associated with vitamin E. (Healthline, 2017). Growing demand for lipids with desirable characteristics is likewise noted (Pham and Pham, 2012).

The market potential of this natural resource from a would-be wasted material after processing the kernel into delicacies is high due to its important use in industry. Its quality which is comparable to olive oil (Pham and Pham, 2012) adds to its potential for commercialization. It can be used as a material in the manufacture of sardines, salad dressing, and many other food preparations to substitute for the imported olive oil.

The research undertaking looked into important aspects of pili pulp oil isolation. It determined the existing methods employed in pili pulp oil isolation and generate an innovative or alternative method to use. It also involved testing of the new method. Having an alternative method of extracting oil from pili pulp that is community-based and farmer-friendly may promote pili pulp oil isolation among the farmers and thus provide another income-generating opportunity for the marginalized sector.

The knowledge and technology that could be generated will be a strong support to nutraceutical and food industries and may promote economic development among pili farmers in the region. With the new knowledge generated on pili pulp oil isolation, new researches and entrepreneurial undertakings may be conceptualized. It

can serve as the basis of new research undertakings in pili product development as well as value-adding to pili by-products which may lead to the promotion of pili pulp oil technologies. It will likewise support the wise utilization of pulp which is generally thrown by households after separating it from the nut and the kernel.

MATERIALS AND METHODS

Methods employed in establishing a protocol for pili pulp oil isolation include simple steps such as a survey to determine the existing pili pulp oil extraction method; analysis of data through a description matrix analysis; developing the protocol; and validation and testing.

Determination of Existing Pili Pulp Oil Extraction Method

Benchmarking on the traditional methods employed by processors involved in pili pulp oil extraction in the region was made by interviewing pili processors. Web quest was likewise employed to determine other methods introduced by researchers and other sectors involved in pili pulp oil isolation. A description of the features of the isolation methods was noted.

Data Analysis and Development of Alternative Isolation Protocol

Description Matrix Analysis was employed in data analysis. The description and features of each protocol were presented in a matrix that served as the basis for deducing the alternative protocol. Descriptive analysis characterizes a phenomenon to be able to answer questions, identify and describe trends and variation, and create new measures of critical aspects (Loeb et al., 2017). The method of analysis was found relevant and appropriate to the data at hand.

Validation and Testing of the Alternative Protocol

The new protocol conceptualized after considering the various methods employed by pili pulp oil extractors was tested to validate its utility in the process. Its potential as an alternative method to be used was determined by using it in isolating pili pulp samples from certain pili varieties obtained from the Department of Agriculture Regional Office V (DA-ROV). It consists of the following steps.

1. Securing and Preparation of Pili Fruit Samples – Pili pulp from sample varieties obtained from DA ROV such as Goa variety, Lanuza, Penafrancia, Magnaye, Laysa and Sorsogon variety was prepared for use in the oil isolation process. These varieties are noted accessions of DA and are the ones available at the time of the coordination.
2. Pulp Oil Isolation - Samples of pili pulp were used in oil isolation using the Alternative method developed from the existing methods. The volume of recovered oil and the percent yield were noted, and the efficacy of the alternative protocol was established.

RESULTS AND DISCUSSION

The study developed an alternative protocol for pili pulp oil isolation from the existing methods employed by pili processors. It likewise involved testing of the new protocol to determine its efficacy in isolating oil from pili pulp of Bicol varieties.

Existing Pulp Oil Isolation Methods

There were three methods noted for pili pulp oil isolation used by processors. These are enzymatic extraction, the DOST method, and the traditional method employed by local oil extractors.

1. Traditional extraction is a method employed by farmers/ pili pulp extractor in the Province of Sorsogon, patterned from the coconut oil extraction method. It involves pulping, pressing, and extracting, then cooking. The pulp was first softened by a local process called "paglanta"; extracting includes mixing, macerating, pressing, and filtering; cooking is heating the extract in a 'carahay" or big sauce pan, until the water components have entirely evaporated and the suspended solid particles have settled as residue. The oil is then transferred to the storage container.

2. DOST Method is composed of simple cooking and filtration tools that process oil extracts from freshly harvested pili nuts using minimal heat (Calleja, 2009). It includes pulping, extraction, filtration, and evaporation to separate the oil from the water. This method has been introduced to pili pulp oil entrepreneurs in Sorsogon by DOST Provincial Office in Sorsogon province. The technique is found friendlier to local processors not only because of its simplicity but also because the process is synthetic chemical-free.

3. Enzymatic extraction involves three operations: pre-treatment, extraction or oil release, and oil recovery (Pham and Pham, 2008). The process entails aqueous extraction involving mechanical and enzymatic degradation of the cell walls. The enzymatic process uses water as solvent and cell wall degrading enzymes to facilitate an effective and mild fractionation of oil, protein, and hulls. The oil found inside plant cells is linked with proteins and a wide range of carbohydrates like starch, cellulose, hemicellulose, and pectin (Pham and Dumanadan, 2015). The inner cell surrounded by a thick wall must be opened so the protein and oil can be released. Thus, when opened by enzymatic degradation, down -stream processing makes fractionation of the components possible to a degree, which is better than the conventional technique like pressing.

The three existing methods have features that can serve as the basis of the new protocol. The practical and feasible features were adopted, and some are considered in coming up with an improved feature to develop a relevant, community-based, and more user-friendly option for the pili pulp oil isolation process.

Knowledge and Innovative Technology Generated from Findings

Analysis of the existing methods employed in pulp oil isolation revealed three general processes: pulping, extraction, and oil isolation. There were, however, specific procedures employed that differed from the existing methods. This study found that maximizing the secretion of oil embedded in the pulp and fractionation of extract components are necessary for the process. Significant knowledge noted in the existing methods employed in pili pulp oil extraction is given in Table 1.

It can be noted from Table 1 that there are procedures employed in the existing methods in pili pulp oil isolation that can be improved to come up with an alternative or innovative method of pili pulp oil extraction. The features of the three existing protocols served as the basis of the new process.

Table 1. Knowledge noted, its implications, and alternative/innovative technology generated.

Procedures / Processes in Existing Methods	Purpose	Implication/s	Alternative/ Innovative Technology Generated
"Paglanta" or pulp softening process	To soften the pulp.	The process is not well defined as to what is the appropriate water temperature to use. There is a need to stabilize the pulping temperature to be employed.	Water temperature ranging from 50°C to 60°C may be employed in the pulping process.
Mechanical pulping macerating and pressing to get the pulp extract	To get the extract containing oil from the pulp.	To enhance the oozing of oil from the network of fibers in the pulp. May be facilitated by using/developing a machine that can do the processes together in one operation.	The use of blender/ similar machine may be introduced in the maceration process. It will facilitate the process and will make it clean and standardized.
Cooking/ Evaporation	To eliminate and separate the water impurity in the extract from the oil components.	Applying heat facilitates the evaporation of water and settling of suspended impurities as residue. Time consumed in carrying out the process may be shortened if the water will be separated by employing other means of separation.	Decantation, flotation and scooping by hand using appropriate scoop may be employed first before cooking/ evaporation. Fractionation of the mixture will save time, resources, and energy that will be utilized in the process.
Use of enzymes in Enzymatic Extraction	To degrade the cell walls in the pulp's fibers so that the oil embedded in it will be released and quickly oozed out of its network.	The procedure is intended to maximize oil isolation. If an alternative method of degrading the pulp's fibers be used to substitute the process, the use of enzyme and synthetic chemicals may be eliminated.	Natural fermentation of the extract may be introduced in the process of oil isolation to degrade the fibers.

In the traditional method the process of softening the pulp "paglanta" was done by approximating the temperature. However, it was noted that pili pulp, when soaked in water of higher temperature than what is necessary, would harden rather than soften, thus the need to investigate the appropriate temperature range that can promote softening of the pulp. Trials were made to determine a standard temperature appropriate to be employed.

The mechanical process of oil extraction needs to be mechanized for it to be facilitated. The use of existing appropriate machines like blender was introduced in the process and findings revealed that doing so really facilitated the maceration and it likewise standardized the procedure and make it more sanitary. It also implied that an all-in-one machine that can do not only maceration but also pressing and filtering may be designed/fabricated for more efficient mechanization of the process.

Innovation in cooking/evaporating the crude extract was introduced by employing fermentation, decantation and scooping or separation using a separatory funnel. The innovative procedure fractionates the crude extract, thereby reducing the volume of water and other impurities thus saving time, resources, and energy.

In the existing enzymatic extraction, the enzyme was used as a tool to degrade the network of fibers that holds the oil in the pulp. The decomposition process by fermentation is the innovative process introduced to facilitate and maximize the secretion of oil.

Figure 1 presented the RPOIM, a method of pili pulp oil isolation. It can be noted from the figure that the alternative protocol consists of three major processes such as extraction and fractionation, oil isolation, and oil recovery.

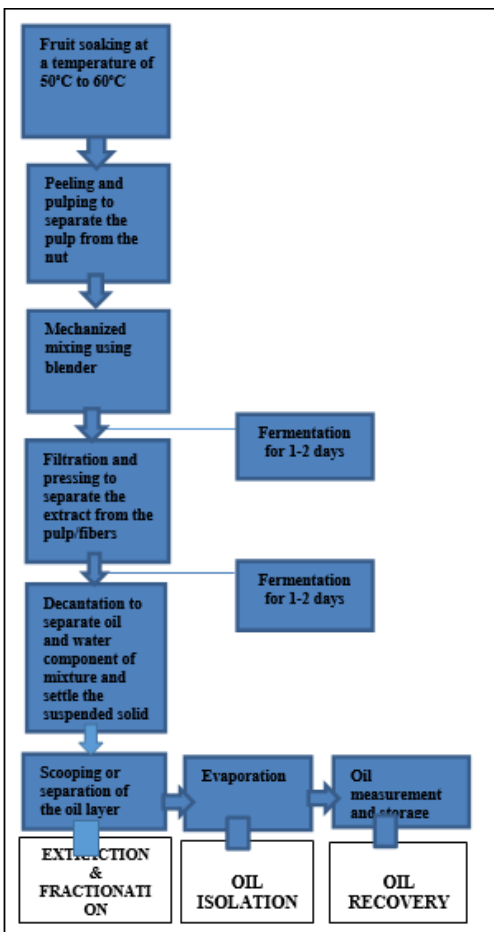

Fig. 1: Innovative/Alternative Pili Pulp Oil Isolation Method (IM-Ramirez Pulp Oil Isolation Method).

During the extraction and fractionation process, several steps were involved. Each of the steps was deduced from the analysis of the description matrix for the existing methods. There were 6 steps involved:

1. Fruit soaking at a temperature of 50°C to 60°C is intended to soften the pulp. Softening the pulp allowed easy extraction of the oil-containing liquid component which is naturally present in it.
2. Peeling and pulping to separate the pulp from the nut is done to obtain a material that can be subjected to an easy extraction process. The nut containing the kernel is hard and woody and must be separated and used for other purposes.
3. Mechanized mixing using a blender is for the degradation of the fibers in the pulp. It is in the network of fibers that oil content is embedded, thus must be destroyed for the oil to ooze out easily and maximize the oil recovery. Fermentation for 1-2 days is an added process in this part to enhance network degradation.
4. Filtration and pressing to separate the extract from the pulp/fibers is the process that resulted in the separation of the oil-containing liquid component. That component must be separated from the pulp for easy separation of the oil. Decomposition of the suspended solids left in the liquid mixture will be enhanced by the added process of settling it for another 1-2 days and to decay.
5. Decantation to separates oil and water component of the mixture and settled the suspended solid. This process will promote the layering of the oil-containing liquid.
6. Scooping and separation of the oil layer is the final process that yielded the oil but still with water impurities and suspended particulates.

Oil isolation is done by employing the process of evaporation intended to

purify the oil-containing layer obtained after scooping. Evaporation is the application of heat that allowed the phase change of the water from liquid to gas thus obtaining the pure pili pulp oil.

Oil recovery is the quantification and storage of the isolated oil after evaporating the water impurities.

Testing of the Alternative Method in Pili Pulp Oil Isolation

Testing the efficacy of the protocol for its intended purpose is one important aspect of establishing an alternative protocol to be recommended as an option to existing and commonly employed processes. RPOIM must be subjected to validation and testing to establish its potential for efficient and practical utilization.

Testing of the developed protocol was done using fruits of different varieties of pili from the Department of Agriculture (DA) Regional Office V such as Goa , Lanuza, Penafrancia, Magnaye, Laysa, and Sorsogon varieties. It was requested from DA to ensure authenticity for easy identification and labeling. Samples are shown in Figure 2.

It can be noted that generally, the color of pili fruit is black with purple characteristics. Some fruits are elongated and wide, while others are elongated but small. Some are rounded and short. The variety which was found bigger than the rest was Penafrancia and Goa followed by Magnaye and Laysa, Sorsogon and ever bearing varieties were noted to be smaller. Statistical test of significance on the average fruit mass however indicated that there are no significant differences in the size of the pili fruit samples used at .05 level of significance. It implied that visual

Fig. 2. Samples Used in Testing the Alternative Protocol.

attributes of size are not standard since these may be affected by the cultural management employed in pili production. Data was only based on the samples at hand.

Pulp of the samples were processed for oil isolation using the alternative protocol, the RPOIM. Result is consistent with the known fact that oil is present in pili pulp as indicated by the successful isolation of oil from majority of the samples. Oil yield is given in Table 2.

Data in Table 2 revealed differences in the oil yield of the samples but the results manifested applicability of the alternative method in isolating oil from pili pulp. Specifically, data indicated that Goa variety has the highest yield of 35.6% followed by Laysa with 25.2%. The rest of the samples showed lower percent yield. One significant finding about oil yield of pili pulp is its connection with the nature of the pulp.

Findings showed that oil yield is higher for varieties with fibrous pulp and thus a potential source of oil.

Those with starchy pulp may be considered for other uses.

Table 2. Oil yield of Pili samples used in testing.

Pili Samples Used in Testing	Mass of Pulp per 4 pcs (g)	Nature of the Pulp	Volume of Oil recovered (mL)	% Yield
Goa	14.6	fibrous	5.2	35.6
Lanusa	12.3	Less fibrous	1.4	11.3
Penafrancia	15.1	starchy	0.5	3.31
Magnaye	12.4	starchy	traces	-----
Laysa	10.3	fibrous	2.6	25.2
Sorsogon	11.7	Highly starchy	traces	-----
Everbearing	8.1	starchy	traces	-----

Applicability of Knowledge and Technology Generated from Findings

The alternative method in pili pulp oil isolation introduced by the study may be used by pili processors who are producing bulk of pili pulp in the processing of fruits to obtain the kernels. It may be used by pili processing households who were not so inclined in adopting highly technical methods of oil isolation such as the enzymatic extraction. It is efficient and cost effective because it uses materials and tools available in the community thus may be regarded as a community-based method of pili pulp oil isolation.

Laysa and goa varieties were noted as potential sources of pili pulp oil and lanuza was likewise found to contain desirable quantity of pulp oil. Nature of the pulp is one good indicator of the oil yield because findings indicated that varieties with fibrous pulp yielded greater volume of oil compared to those with starchy pulp. Entrepreneurs focusing on pili pulp oil business may be advised to plant Laysa, Magnaye and Orbase varieties in their farms.

CONCLUSION

There are three existing pili pulp oil isolation methods employed by pili pulp oil extractors in the region such as traditional method, DOST recommended method and the enzymatic extraction. RPOIM was developed based on the features and noted deficiencies of the existing protocol. It is characterized by three generic processes such as extraction and fractionation, oil isolation and oil recovery. Fermentation of pulp for 1-2 days after mechanized mixing and after extraction is a distinct feature of the alternative method.

Testing of the new technology manifested applicability of the recommended option in pili pulp oil isolation as it was effectively used in determining percent oil yield of samples. It can be used by pili processors who are producing bulk of pili pulp in the processing of fruits to obtain the kernels. It may be used by pili processing households who are not so inclined in adopting highly technical methods of oil isolation such as the enzymatic extraction.

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