UTILIZING NYAMPLUNG OIL EXTRACTION BYPRODUCTS FOR SUSTAINABLE PROCESSES: PROSPECTS AND CHALLENGES OF THE ZERO WASTE INDUSTRY

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Abstract:Background: Approximately 73% of the waste from processing nyamplung fruit is leftover cake and shell from pressing, which is a significant amount. Despite the fact that the garbage was converted into animal feed. Because there are still oils and resins that can be used to create lubricant, colors, and pharmaceutical items, this waste treatment needs to be controlled by using the reuse, reduce, and recycle principles to a variety of products. **Patient and Method:**Fruit shells can be used to make liquid smoke for wood preservatives and charcoal briquettes for fuel. Cake, a solid byproduct of the pressing of seeds, has a high crude protein content and can be used as animal feed. Gum, a liquid byproduct, contains resin with a high coumarin content and has the potential to be used to make drugs. The resin is a byproduct of the nyamplung seed oil extraction process, which also yields many bioactive substances, including xanthones and jacareubin, which have antiulcer properties.**Conclusion:**Data analysis has been done on the yield and physicochemical characteristics of the outcomes of nyamplung waste extraction. It has been suggested that using nyamplung waste could lead to a waste-free industry. In order to develop a zero waste industry model, future perspectives on the processing of nyamplung fruit waste have been provided in this study.
Keywords: By-product, extraction, industry, lubricant, pharmaceutical, zero waste.

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INTRODUCTION

The waste of the seed shell, which is expected to account for between 30 and 40 percent of the nyamplung fruit but has not been investigated for use, is a result of the processing of nyamplung seed oil. Obviously, recycling the nyamplung seed shell trash will be beneficial and profitable. If it is not used properly, the nyamplung seed shell, which is a byproduct of the manufacture of nyamplung oil, will pollute the environment [1]. Nyamplung oilcake waste can be observed accumulating around the industrial area, where it begins to smell a little rotten and get moldy. The end products of processing nyamplung also contain nutrients that can be utilized by soil and plants, just like the rest of the waste from other agricultural goods [2].

Nyamplung fruit waste has the potential to be used as bioenergy products, fertilizers, particle boards, animal feed, and other processed non-food items due to its presence of carbs, crude fiber, oil, and protein. Solvents such as methanol, ethyl acetate, and chloroform can be used to extract oil [3; 5; 4] Nyamplung fruit has economic potential based on its chemical composition, and if the waste generated during production is handled further, the process can result in byproducts with a high added value and no waste [6].

According [7] to the article, fruit shells can be used to make liquid smoke for wood preservatives and charcoal briquettes for fuel. Cake, a solid byproduct of pressing seeds, has a high crude protein content and can be used as animal feed. Gum, a liquid byproduct, contains resin with the potential to be used as medicine due to its high coumarin content. The resin is a byproduct of the extraction of nyamplung seed oil, which has many bioactive components with antiulcer activity, including xanthones and jacareubin [8]. Nyamplung fruit has economic potential based on its chemical composition, and if the waste generated during production is handled further, the process can result in byproducts with a high added value and no waste. [6]

Aim of the study: This assertion suggests that there is a wide range of potential uses for nyamplung fruit trash. To create products with a zero waste approach, this potential must be seen. Therefore, in order to reduce industrial nyamplung waste, it is vital to examine the possibility of using nyamplung waste as a valuable product. Nyamplung fruit waste can be used to make biomaterial products that have both commercial and ecological value while also reducing environmental pollution and maintaining public health.

METHOD

This research was conducted in 2022. The nyamplung fruit obtained came from KHDTK Carita, Banten. The nyamplung fruit by-product used is the result of pressing nyamplung seeds. The by-product obtained is dried to a moisture content of 5% and the size of the nyamplung fruit shells is reduced to

20 mesh. Extraction was carried out in binary with a ratio of methanol and hexane 4:2; 3:3; 2:4. The extraction process conditions were carried out with a heating temperature of 50-60 oC with a stirring condition of 200 rpm.s

Determination of physicochemical properties

1 Acid Value

Samples weighting 5 to 10 g were weighted in a 250 mL Erlenmeyer. Also included was 25 mL of 95% neutral alcohol, which was heated until boiling. After the mixture had cooled, 2 drops of phenolphthalein indicator were added. The solution was then titrated with 0.1 N KOH solution until the pink hue lasted for a few seconds [9].

2 Iodine Value

Sample dissolved in 10 mL of chloroform after being weighted in Erlenmeyer at 0.25 g. After that, the sample was treated with up to 25 mL of the Wijs solution. The Erlenmeyer is then closed and left unlocked. Bind bromine for 30 minutes in a dim environment while periodically shaking it. Then, 15% KI is added to it while it's still being shook. Next, add 100mL of the purest water you can. The remaining iodine in the mixture is titrated with a 0.1 Na2S2O3 solution N when the solution turns pale yellow. The titration was then continued until the blue color disappeared after a few drops of the 1% starch solution indicator had been added. Blanks are produced using the same method [10].

3 Viscosity

In the Ostwald viscometer tube, Aquades is heated to a temperature of 40 °C in a water bath. It is noted how long it took to react in order to achieve the tera mark. The oil is then heated. In a tube after being placed in a water bath at a temperature of 40 °C. Viscometer by Ostwald. Required reaction time to cross the tera mark say. The formula below is used to determine the viscosity.

$$Viscosity = 0.7 \times \frac{t2}{t1}$$

Information:
t1 is the amount of time (in seconds) required for distilled water to flow.
t2 is the reaction time in seconds required for biodiesel to flow.

4 Density

Ten milliliters of the sample were weighed, and the density was determined using a pycnometer. The pycnometer is weighed after being filled with an oil sample and calibrated to the appropriate limit.= %

Number of positive test results

RESULTS

Nyamplung pulp and shells are waste products from the pressing of nyamplung fruit. Nyamplung fruit waste has the potential to be transformed into cutting-edge materials, particularly for resin and bioenergy applications. Currently, the majority of nyamplung fruit waste is turned into products for animal feed. Fruit from nyamplung contains 40% seeds and 60% shell. Nyamplung fruit shell output is high, but it has not been used to its full potential. Even if the potential of the resin contained in the shells can still be used to create goods with high added value, the processing of nyamplung shells is still only now confined to animal feed, organic fertilizer, and briquettes [6].

There was a significant difference in the oil acid number between methanol: hexane solvent concentrations of 2:4 and concentrations of 3:3 and 4:2. In the resin there is a significant difference in the acid number at a concentration of 4:2 with a concentration of 3:3 and 2:4. There is no significant difference between the oil and the iodine number. There is a significant difference in the viscosity of the oil at a concentration of 3:3 with a concentration of 2:4 and 4:2.The oil yield is obtained from the comparison between the weight of the oil produced and the weight of the material used. The yield of the resulting oil ranges from 2-9%, while the resin ranges from 1-3%. This is because the oil and resin materials contained in the dregs and shells of the nyamplung seeds have been maximally extracted in the previous stage, thus allowing the yield of oil and resin to be low at this stage. This low yield is also due to the large amount of oil absorbed in the pores of the material so that the yield obtained is not optimal. The yield of the extraction process is also affected by the extraction time, extraction temperature and solvent ratio [11].

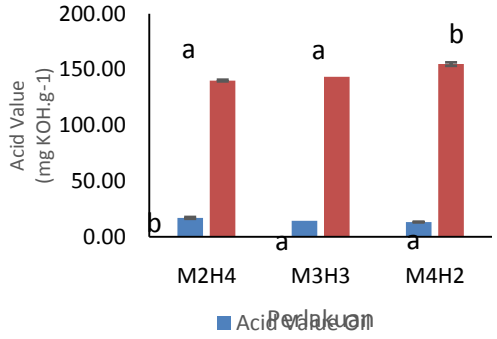

Figure 2 Oil and resin acid numbers based on the ratio of methanol and hexane

The results of analysis of the diversity of the acid number of nyamplung oil showed that the ratio of hexane and methanol had a significant effect on the acid number. Oil acid number values range from 13 -16 13-16 mg KOH/ g material. This is in line with [9], the acid number of nyamplung oil is 6-20 13-16 mg KOH/ g material. According to [10], the acid number of the oil ranges from 7.8-18.5 13-16 mg KOH/ g material. The low acid number in the oil causes the oil to have the potential to be used as a biofuel, this is because the high acid number in the fuel can cause corrosion and deposits on the engine [11] The high acid number is due to the oxidation reaction of peroxide compounds which form aldehyde compounds. Aldehydes will be further oxidized to form carboxylic acids which cause high acid numbers [15].

The results of the analysis of the diversity of the acid number of nyamplung resin showed that the ratio of hexane and methanol had a significant effect on the acid number. The acid

number of the resin in this study ranged from 140-158 13-16 mg KOH/ g material. This is in line with [12], the acid number of nyamplung resin is 108-152 13-16 mg KOH/ g material. According to [13] the acid number of the resin ranges from 159.6-194.7 13-16 mg KOH/ g material. The high acid number in the resin is due to the presence of phenolic compounds 4-phenylcoumarin calophylloidea, dehydrocycloguanandin (DGC), calophyllin-B (CPB), jacareubin (JR), 6-desoxy jacareubin (DJR), mesuaxanthone (EX) [13].

In Figure 2 it can be seen that the acid number of nyamplung oil (13 -16 13-16 mg KOH/ g material) and the acid number of the resin (140-158 13-16 mg KOH/ g material) have a significant difference. This difference is influenced by the amount of free fatty acids contained in nyamplung oil and resin. The fatty acids contained in nyamplung oil are non-polar such as oleic and linoleic acids, while the resin contains derivatives of cinnamic acid, begonia acid, phenolic and polyphenolic compounds [17]. This causes the acid number of the resin to be higher than the acid number of the oil.

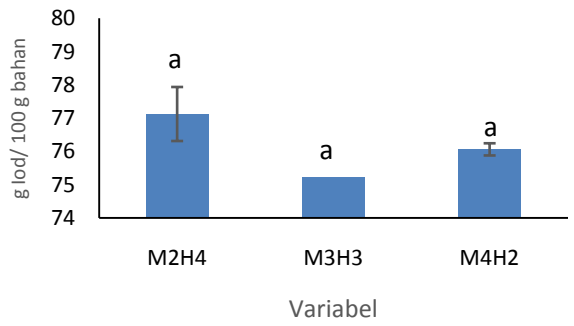

Figure 3. ICO iodine number based on the ratio of methanol and hexane

Another quality parameter for vegetable oil is the iodine number. Figure 3 shows the results of the analysis of variance showing that there is no significant difference in the iodine number to the hexane/methanol ratio. The iodine value of nyamplung oil ranges from 75-77 gIod/100 g of material. The greater the amount of iodine absorbed, the more double bonds there are in the oil and the more unsaturated the oil [14]. The iodine number can determine the type of oil produced, namely drying oil, semi-drying oil, and non-drying oil. Drying oil has an iodine number of more than 130, semi-drying oil has an iodine number of 100 – 130, and non-drying oil has an iodine number of less than 100 [15,16]. Based on this, nyamplung oil is included in the non-drying oil group (<100 g iodine/100 g material).

Low iodine numbers are preferred for processing into biofuels [4]. The fatty acid composition of nyamplung oil is dominated by unsaturated fatty acids (61.4%) such as oleic acid, palmitoleic acid, linolenic acid, and linoleic acid [21]. This acid content causes nyamplung oil to be used as raw material for biodiesel, cosmetic and pharmaceutical products. Oil to be used as a biofuel must have an iodine number lower than 115 mg Iod/g, and nyamplung oil has the potential to be used as a biofuel, particularly as Pure Plant Oil (PPO) or biofuel [22]

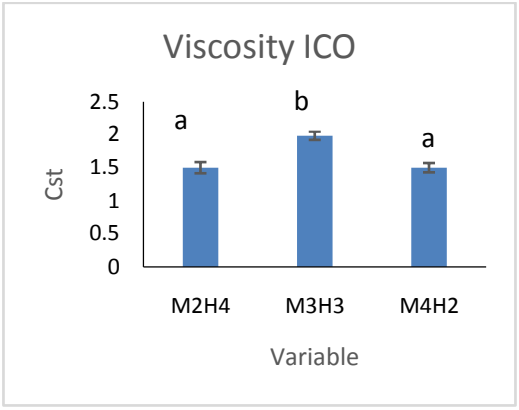

Figure 4 ICO Viscosity based on the ratio of methanol and hexane

The results of the analysis of the viscosity of nyamplung oil were significantly different with respect to the hexane and methanol ratio as shown in Figure 4. The viscosity of nyamplung oil in this study ranged from 1.5-2 cSt. The difference in oil viscosity is influenced by several factors, including the degree of saturation of the dominant fatty acids contained and the presence of other impurity components.

Viscosity is an important consideration for fuels. At this stage the viscosity is suitable for biodiesel production. The quality requirements for biodiesel kinematic viscosity are 2.3-6 cSt at 40oC [19]. Viscosity is an important factor in the breakdown mechanism and fuel atomization when the fuel is injected into the combustion chamber [24]. If the viscosity is too high, the injector is unable to break down the fuel into smaller pieces so that evaporation and combustion run smoothly.

Potential Waste Nyamplung and its utilization

A quick peroximate study was done to determine the likelihood of nyamplung waste. Table 1 displays the findings of the peroximate study.

Tabel 1 Characterization of nyamplung waste

Parameter	Reult (%)
Water Content	10,90
Ash Content	1,73
Lipid	2,57
Protein	28,56
Carbohydrate	56,23
Crude Fiber	26,17

Nyamplung waste has high levels of protein (28.56%), carbs (56.23%), and crude fiber (26.1%), according to Table 1 findings. These elements may potentially be turned into useful products if they were treated further. The crude fiber content of nyamplung fruit waste can be processed into particle board products, while the protein content can be used as animal feed. If the fruit waste's carbohydrates are further processed, they can be used to make bioethanol. The spesific contents provided

below.

Protein

Building and maintaining tissue and organ proteins, supplying food amino acids, supplying energy to the body, supplying a source of body fat, supplying a source of blood sugar, supplying a source of blood glycogen, supplying a source of body enzymes, supplying the fundamental building blocks for at least one vitamin B complex, and supplying some components of DNA, RNA, and ATP are all functions of protein [25]. Protein is essential for managing all of the bodily functions that take place in the tubule. The protein contained in nyamplung waste can be used to make animal feed products, and if further processed, this protein can be used in detergent. Protein also serves as a digestive enzyme in the body that is typically referred to as an enzyme. Enzymes have a variety of uses, including the manufacture of detergent, improving the efficiency of burning operations, and strengthening contact lenses. Enzymes are used in manufacturing to create the large molecular process known as depolimerization [26].

Carbohydrate

There are four different forms of carbohydrates: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. In the course of photosynthesis, carbohydrates can be transformed into cellulose and other plant products [27]. Around 75% of the weight of plant biomass is made up of carbohydrates, which are divided into four categories: sugar, starch, cellulose, and hemicellulose. Biomass waste can be used to produce carbohydrates. Because of their intricate structure and the existence of hard, mutually penetrating hydrophobic lignin layers, carbohydrates can be employed as feed ingredients but cannot be administered directly to animals. Plant biomass serves as a source of carbohydrates, which results in the production of mono- and disaccharide compounds [28]. The conversion of carbohydrates into products is presented in Figure 1.

Figure 5 illustrates how the conversion of carbohydrates might result in the production of bio-base products. The amount of carbohydrates in Nyamplung fruit waste ranges from 56.23%. Nyamplung fruit waste has the potential to be converted into goods derived from carbs rather than being utilized simply as animal feed when considered in light of its high carbohydrate content. Nyamplung waste has the potential to be used as a component in the manufacturing of ethanol due to its relatively high carbohydrate content. Alcohol known as ethanol is produced when materials containing sugar, starch, and cellulose are fermented. By hydrolyzing carbohydrates into glucose and adding an acid, bioethanol is produced. A liquid fuel made from renewable sources is bioethanol [29].

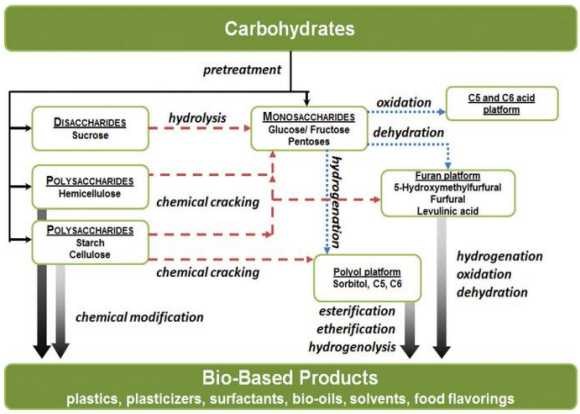

Figure 5 Conversion of carbohydrates through chemical means

Crude Fiber

The amount of cellulose, pentosan, and lignin that cannot be digested is referred to as crude fiber. Crude fiber in feed aids intestine peristalsis, prevents grain from clumping in tissues, speeds up digestion, and promotes the growth of the digestive system [30]. Coarse fiber has the potential to be used as particle board, this was shown in a study [31] which used jatropha dregs to become particle board because the crude jatropha fiber content ranged from 28 – 33%.

The amount of crude fiber found in nyamplung waste was 26.17%. There is no possibility of using high crude fiber as animal feed. This is because the feed's high crude fiber content will decrease its digestibility because crude fiber contains difficult-to-digest components like lignin [32]. Nevertheless, this unprocessed fiber has the potential to be used to make particle board when there is a demand for boards. This is incredibly high and is caused by wood particles, hence substitute materials are required. One such material is sampling fruit waste.

Utilization of Nyamplung

Various items have been made thus far from the processing of nyamplung fruit waste. The nyamplung fruit shell is the sole part of the trash that can be processed; mechanical and solvent extraction's byproducts have not been used to their full potential. Nyamplung shell can only currently be processed into activated charcoal and animal feed. Similar to how nyamplung waste is currently mainly utilized for animals, so. In fact, nyamplung fruit waste has the potential to be used as a product with added value, as can be observed from the makeup of the compounds it contains.

Currently, soap products are made from the by-product (glycerol) of the biodiesel processing process. Resin is created as a byproduct of the degumming process. This resin is utilized as a primary ingredient in pharmaceuticals

and cosmetics. To improve the efficiency of turning agro-industrial waste into goods, particularly nyamplung fruit trash, appropriate technology in waste management needs to be increased once again. Possible nyamplung fruit waste products are animal feed, compost, and resin.

Nyamplung waste has the potential to be used as an animal feed concentrate due to its high protein content (28.56%) and crude fiber content (26.17%). According to [33] While adding nyamplung seed meal to fermented complete feed did not enhance nutrient intake, it did increase body weight and feed conversion and lower feed expenses and feed cost per gain. Up to 15% of nyamplung seed meal can be utilized as an element in animal feed.

According to [6] the solid waste of nyamplung fruit can make approximately 42–63% of the processed dry beans in the form of remaining pulp from the pressing process. Utilizing industrial waste is anticipated to benefit society in other ways, such as lowering environmental pollution and preserving public health, as well as by adding value that is both economically and ecologically beneficial. The products of processing nyamplung also contain nutrients that can be used by soil and plants, much like the rest of the agricultural materials. Nyamplung cake compost satisfies the requirements of SNI o. 19-7030-2004 (Specification for Compost from Domestic Organic Waste) in terms of total DHL value, C/N ratio (10.97%), N content (3.85%), P (0.20%), and K (1.71%). Composting with a prouponic starter produces the highest grade compost.

The nyamplung fruit's shell contains a lot of resin. By applying a solvent for extraction, the resin is obtained. Diverse solvents are used to extract the resin from shells in an effort to find the one that will yield the most resin of the highest quality and quantity while also being the most cost-effective. Methanol is the best solvent to utilize since it has the highest resin extraction capacity and is the least expensive when compared to other solvents like ethanol and hexane [34].

Future Persprective

Currently, nyamplung fruit waste is used to make a variety of products. Since the dregs from mechanical and solvent extraction have not yet been fully utilized, only the fruit shell is now processed when dealing with nyamplung fruit waste. Activated charcoal and animal feed are the only two products that can currently be made from nyamplung shell. similar to how nyamplung waste is primarily used for animals at the moment. In reality, as can be seen from the composition of the compounds it contains, nyamplung fruit waste has the potential to be used as a product with additional value.

The nyamplung fruit waste that is currently available has been transformed into compost, charcoal, resin, and animal feed. During the production process, these components have both benefits and drawbacks. The only way to utilize waste and stop waste from entering the production process again is to thoroughly understand it. Nyamplung fruit garbage can provide business actors with increased economic added value if used effectively. Due to its high protein, carbohydrate, and crude fiber content, nyamplung fruit waste has the potential to be employed in a variety of goods with higher added value than those that are currently on the market. Sustainability must be taken into account at every stage of the business acting process. Of course, the goal is to have a less impact on the environment.

CONCLUSION

Nyamplung fruit waste typically has significant quantities of protein, carbs, and crude fiber, which can be used to make particle board, bio-oil, resin, plasticizer, and bioenergy. Due to its high carbohydrate content, nyamplung fruit can be processed into a wide range of goods, including plasticizers and particle board. Management of nyamplung fruit waste can improve economic value while lowering environmental pollution. The conditions of the extraction of nyamplung shells and dregs using hexane and methanol generally affect the yield and quality of the oil and resin produced. the acid number of the oil ranges from 13-16 mg-KOH.g-1, the viscosity ranges from 1.5-2 cSt, and the iodine number is 75-77 g Iod/100 g of material, while the results of research on nyamplung fruit resin have an acid number of 140 -158 mg-KOH.g-1, the yield ranges from 2-4%. Nyamplung oil obtained in this study has the potential to be used as biofuel.

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