Fatty acid composition of two new pandanus oil from Lanny Jaya District, Papua: *Pandanus iwen* and *Pandanus jiulianettii* seed oil

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Abstract. Papua has the highest number of flora species in Indonesia. One of the endemic species is the screw palm (Pandanus) fruits which can be potential plant oil. Plant oil has attracted many interests because of its function for food and non-food product development. The objective of this research was to identify the fatty acid composition of Pandanus iwen and Pandanus jiulianettii oil extracted using the method of wet rendering with an aluminium pan. The fatty acid composition was analysed using gas chromatography-FID method. The result showed eleven fatty acids found in both Pandanus iwen and Pandanus jiulianettii. They are C12:0, C14:0, C16:0, C18:0, C20:0, C22:0, C16:1, C18:1, C18:2, C18:3, and C20:1. Both the saturated and unsaturated fatty acid composition of Pandanus iwen (saturated 24.48%, unsaturated 35.10%) is higher than Pandanus jiulianettii (saturated 21.95%, unsaturated 32.58%).

1 Introduction

Indonesia has an abundance of flora, most of which is found on Papua Island, with enormous potential for commercial use [1]. The screw palm (*Pandanus*) is a tropical plant found in Papua that has long been a source of various essential product for the local population. Pandanus, a genus consisting of palm-like plants, features elongated green leaves resembling swords. These leaves possess a dense cuticle and spines along the midrib's underside and margins. The development of leaves and floral elements occurs in a three-rowed phyllotaxy, characterized by twisted stems that create a spiral effect. The trunks of Pandanus trees display a gray hue, while prop roots are a common sight.

The mountain communities widely use the *Pandanus* genus (Pandanaceae) as traditional roofing (*Pandanus* leaves) and baskets (*Pandanus* roots). Meanwhile, the fruit is consumed by the local population for traditional medical purposes and as a source of protein and carbohydrates [1–3]. Papuans and Papua New Guineans who live in the highlands rely on *Pandanus jiulianettii*, one of the several species of the *Pandanus* plant, for food, medicine, and ceremonial purposes [4]. Moreover, *Pandanus iwen* and *Pandanus jiulianettii* were utilized as medicinal resources by the Dani tribe at Wamena [5]. Therefore, fruits of the *Pandanus* plant have potential as food-stuffs and medicine.

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The chemical composition of *P. iwen* and *P. jiulianettii* fruit is dominated by 50% and 47% (respectively) fat [1]. It indicates that the fruit of the *Pandanus* plant could possibly be used to produce edible oil. However, there is no published information regarding the fatty acid content of *P. iwen* and *P. jiulianettii* seed oil. Thus, the aim of this research was to prescribe the saturated and unsaturated fatty acids of both *Pandanus* seed oil and their possible commercial uses.

2 Materials and Methods

2.1 Raw materials

Pandanus were obtained from the Lanny Jaya District at 1500 to 3000 m above sea level (Latitude 04º 00' 11.9" and 04º 00' 14.0" South and Longitude 138º 57' 32.4" and 138º 57' 33.7" East) and transported to the Biology Laboratory, at the Biology Department, Cenderawasih University. Samples were from *Pandanus iwen* and *Pandanus jiulianettii* fruit that matures (Fig. 1a). *Pandanus* oil is obtained through the endosperm (kernel) extraction process (Fig. 1b).

Fig. 1. *Pandanus* fruit: (a) The mature fruit; (b) The endosperm (kernel) [6].

2.2 Procedures

2.2.1 Extraction of oil from the Pandanus

Pandanus seed oil extraction refers to Zebua and Purnamasari [6] using a wet extraction method with an aluminum pan [6]. The endosperm (kernel) of *Pandanus* is washed with water. Endosperm (1 kg) blended with water (ratio 1:1), then heated for 1 hour at 60 °C – 70 °C, and centrifugated at 1,000 rpm for 2 minutes. Fig. 2 shows the extracted *Pandanus* seed oil.

2.2.2 Analysis of fatty acid composition

Pandanus oil's fatty acid content was evaluated using GC-FID (Shimadzu, GC-2014) referred to as AOAC 969.33 (AOAC 2005). FAME-37 was used as the identification and quantification standard. Fatty acid quantification was computed using the internal normalization procedure.

2.3 Statistical analysis

The data of fatty acids from *P. iwen* and *P. jiulianettii* were analyzed descriptively by comparing the types of fatty acids contained in each sample obtained. GC-FID analysis for each sample was repeated three times to improve its accuracy.

3 Results

Pandanus jiulianettii fruit with a gross weight of 3 kg produces about 2 kg of endosperm. From 2 kg of extracted endosperm can produce approximately 100 ml of oil. Meanwhile, *Pandanus iwen* has a small fruit size with a gross weight of 1 kg producing 700 grams of endosperm which after being extracted produces approximately 15 ml. The oil obtained is stored in a bottle (Fig. 2).

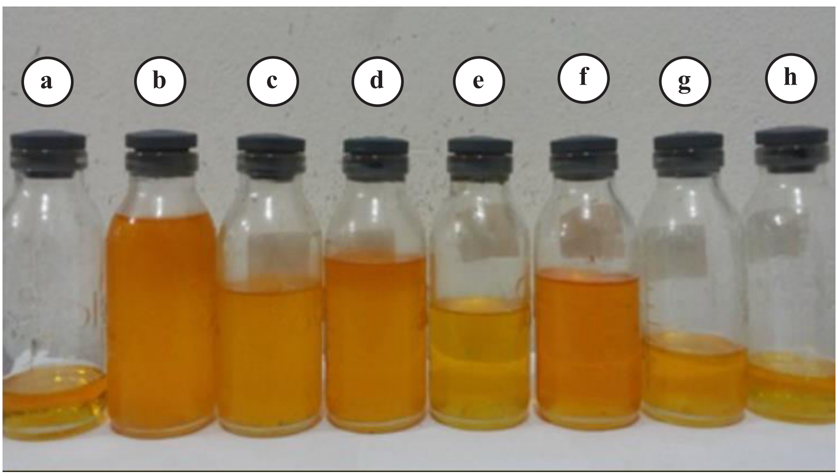

Fig. 2. The oil of *Pandanus iwen* (a, e, g and h), and *Pandanus jiulianettii* (b, c, d, and f).

3.1 Total of fatty acid composition and distribution profile

GC-FID was used to analyze the fatty acid composition of *Pandanus*. The results (Table 1) show that *P. iwen* has higher total fatty acid content than *P. jiulianettii* (59.75% and 54.65%, respectively).

The 11 fatty acid compounds present in *P. iwen* and *P. jiulianettii* seed oil, and each species had a variated ratio of fatty acids (Table 1). For example, the amount of palmitic acid in *P. jiulianettii* were 18.42%, less than *P. iwen* (20.75%). The complete fatty acid composition was shown in Table 1.

P. iwen has the higher concentration of unsaturated fatty acid compared to saturated fatty acid (35.01% and 24.48%). Likewise, the concentration of unsaturated fatty acid in *P. jiulianettii* was higher than saturated fatty acid (32.58% and 21.95%). However, *P. iwen* has the higher concentration of MUFA than PUFA (17.71% and 17.39%), in contrast to *P. jiulianettii* which showed lower MUFA compared to PUFA (15.48% and 17.10%, respectively).

3.2 Saturated fatty acid composition

Based on Table 1, the total saturated fatty acid in *P. iwen* is higher than that in *P. jiulianettii* (24.48% and 21.95%). Palmitic was the most saturated fatty acid found in both *Pandanus* samples, accounting for 20.75% and 18.42%, respectively. Additionally, minor concentrations of a few fatty acids, including lauric acid (0.01% and 0.02%), myristic acid (0.04% and 0.04%), stearic acid (3.39% and 3.16%), arachidic acid (0.24% and 0.26%), and dodecanoic acid (0.05% and 0.05%, respectively), were found in *P. iwen* and *P. jiulianettii*.

Table 1. Fatty acid of *Pandanus iwen* and *Pandanus jiulianettii*.

Fatty acid composition			***Pandanus iwen* (%)**	***Pandanus jiulianettii* (%)**
Saturated fatty acid		C8:0	nd	nd
		C10:0	nd	nd
		C12:0	0.01	0.02
		C14:0	0.04	0.04
		C15:0	nd	nd
		C16:0	20.75	18.42
		C18:0	3.39	3.16
		C20:0	0.24	0.26
		C22:0	0.05	0.05
		Total	24.48	21.95
Unsaturated fatty acid	MUFA	C14:1	nd	nd
		C16:1	0.03	0.03
		C18:0	17.59	15.35
		C20:1	0.09	0.10
		Total	17.71	15.48
	PUFA	C18:2	17.32	17.02
		C18:3	0.07	0.08
		Total	17.39	17.10
Total			35.01	32.58
Unknown			0.17	0.12
Total of fatty acid			59.75	54.65

Note: nd - non detected, MUFA: monounsaturated fatty acid, PUFA: polyunsaturated fatty acid

3.3 Unsaturated fatty acid composition

Significant amounts of unsaturated fatty acids were also discovered in *P. iwen* and *P. jiulianettii*, according to a study of the unsaturated fatty acid of *Pandanus* oil (Tabel 1). The main MUFA found in *P. iwen* and *P. jiulianettii* seed oil is oleic acid (17.59% and 15.35%, respectively). High levels of PUFA also present in *Pandanus* seed oil, i.e., linoleic acid (17.32% in *P. iwen* and 17.02% in *P. jiulianettii*). The *P. iwen* and *P. jiulianettii* oil also contain a relatively small of palmitoleic acid (0.03% and 0.03%), eicosenoic acid (0.09% and 0.10%), linolenic acid (0.07% and 0.08%, respectively).

4 Discussion

Recent studies have delved into the physicochemical properties of the Pandan Kelapa Hutan (*P. jiulianettii* Martelli), revealing intriguing findings. The oil has been found to possess desirable characteristics, including a high total phenol content, significant carotenoid and vitamin E levels, and potent antioxidant activities [8]. These attributes suggest that *Pandanus*-derived oil may hold promise as a viable alternative to conventional vegetable oils, potentially offering nutritional and health benefits to consumers.

The palmitic, oleic, and linoleic acid obtained from oil and fruit extract of *P. iwen* and *P. jiulianettii* are shown in Table 2. Compared with fruit extract, *P. iwen* in oil extract has the lower palmitic acid (23.22% and 20.75%), likewise in *P. jiulianettii* fruit and oil extract (28.66% and 18.42%, respectively). Decreased concentration of palmitic acid can be caused by the process of oil extraction at 60 °C – 70 °C.

In contrast, oleic and linoleic acid in both *Pandanus* oil were higher than *Pandanus* fruit extract (Table 2). Thus, *Pandanus* fruit needs extracted into oil to produce higher oleic and linoleic acid content.

Table 2. Palmitic, oleic, and linoleic acid of *Pandanus iwen* and *P. jiulianettii* oil and fruit extract

Fatty acid composition	***Pandanus iwen* (%)**		***Pandanus jiulianettii* (%)**	
	Oil [a]	Fruit[b]	Oil[a]	Fruit[b]
C16:0	20.75	23.22	18.42	28.66
C18:1	17.59	17.42	15.35	9.29
C18:2	17.32	1.39	17.02	0.33

a = primery data, b = Kogoya *et al*. [1].

4.1 Comparison of fatty acid composition from *Pandanus* seed oil and other seed oil

Research indicates that *Pandanus*-derived oil has a fatty acid composition that is significantly different from generally oils [1, 7-10]. Table 3 lists some of these notable differences composition of the fatty acid.

Oleic and linoleic acids, which can make up as much as 42% of the overall fatty acid content, are the main characteristics of *Pandanus* seed oil. The oil derived from *P. conoideus*, corn, canola, soybean, sunflower, peanut, and olives all have a higher percentage of unsaturated fatty acids than saturated fatty acids [1, 8-10], such as in *Pandanus* seed oil. In contrast, palm oil is high in palmitic acid, while coconut and palm kernel oil are mostly made up of saturated fatty acids like lauric acid and myristic acid [7].

The fatty acid content of *P. iwen* and *P. jiulianettii* seed oil are promising sources of valuable fatty acids, with a favourable profile of saturated fatty acids, PUFA, and MUFA.

Table 3. Content of fatty acids in the various seed oils.

Fatty acid	PI	PJ	PC	CO	PK	PO	CR	CN	SO	SU	PE	OL
∑ SFA	24.48	21.95	16.42	77.40	75.65	50.20	14.10	8.12	17.24	12.23	17.37	19.38
C12:0	0.01	0.02	0.12	49.00	49.25	0.10	nd	nd	nd	nd	nd	nd
C14:0	0.04	0.04	0.07	15.50	16.30	1.00	nd	0.10	0.08	0.12	0.11	nd
C16:0	20.75	18.42	16.04	9.35	8.00	44.00	11.30	5.17	11.35	6.68	9.35	16.50
C18:0	3.39	3.16	nd	3.45	2.10	5.00	2.40	2.14	4.74	5.13	3.46	2.30
C20:0	0.24	0.26	0.19	0.10	nd	0.10	0.30	0.28	0.54	0.30	1.34	0.43
C22:0	0.05	0.05	nd	nd	nd	nd	0.10	0.43	0.53	nd	3.11	0.15
∑ MUFA	17.71	15.48	53.82	6.30	16.35	41.30	28.00	59.81	23.39	27.25	46.17	68.50
C16:1	0.03	0.03	1.05	nd	nd	0.10	0.20	0.23	0.09	0.19	0.06	1.80
C18:1	17.59	15.35	52.50	6.30	16.35	41.20	27.60	58.45	23.30	26.65	44.78	66.40
C20:1	0.09	0.10	0.27	nd	nd	nd	0.20	1.13	nd	0.41	1.33	0.30
∑ PUFA	17.39	17.10	7.13	2.50	1.65	8.50	56.10	30.33	56.81	58.69	34.04	18.00
C18:2	17.32	17.02	6.12	2.50	1.65	8.00	55.40	24.90	51.23	58.52	33.78	16.40
C18:3	0.07	0.08	1.01	nd	nd	0.50	0.70	5.43	5.58	0.17	0.26	1.60

PI – *Pandanus iwen*, PJ – *Pandanus jiulianettii*, PC – *Pandanus conoideus* [1], CO – coconut [7], PK – palm kernel [7], PO – palm [7], CR – corn [8], CN – canola [9], SO – soybean [9], SU – sunflower [9], PE – peanut [9], OL – olive [10].

4.2 Potential application of *Pandanus* seed oil in food and non-food industry

Pandanus seed oil has a lot of potential for use in both food and non-food industries. In the food industry, *Pandanus* oil could be used as a cooking oil, or as an ingredient in processed foods. The presence of saturated fatty acid, primarily palmitic acid in *Pandanus* oil may contribute to its enhanced thermal stability and suitability for various culinary applications, potentially rivalling desirable characteristics of palm oil. Besides, palmitic acid is known for their potential to positively impact cardiovascular health [11]. Palmitic acid from *Pandanus* oil has the potential as a raw material for certain diabetics' products

[12]. Several applications of palmitic acid in food sector i.e., as a food additive, and food component in gluten-free food product (pasta, biscuits, flours, and bread products) [13, 14].

Oleic acid was believed to have a role in several biological processes as antioxidant [15], and has positive effects on TD2M and insulin resistance, acting as an anti-inflammatory and inhibiting endoplasmic reticulum (ER) stress, preventing the insulin signalling pathway from being attenuated, and enhancing b cell survival [12]. In addition, Oleic and linoleic acid also provide therapeutics and prophylactics effects of cardiovascular and inflammatory diseases in human body [16]. Also, consuming linoleic acid lowers cholesterol and triglyceride contents in patients with hypercholesterolemia by up to 50% [17].

Oleic and linoleic acid are widely used as functional ingredients in various food sectors such as drinks, confectionary, canned foods, infant milk formulas, and bakery products [18]. More than 80% of all fatty acids were found in baked products and chips from the Serbian market, which were classified as palmitic, oleic, and linoleic acids [19].

Additionally, the appearance of bioactive compounds like carotenoids and phenolic compounds in *Pandanus* oil [6] may provide added nutritional and health benefits when incorporated into food products [20]. In 2022, Erzhad et al. [21] produced goat milk kefir products by incorporating *P. conoideus* oil extract into goat's milk. The outcome demonstrated a rise in the overall lactic acid bacteria in the kefir, thereby establishing it as a probiotic functional food [21].

In the non-food industry, *Pandanus* oil could have potential applications in cosmetic and personal care products, due to its rich fatty acid profile and antioxidant properties [6]. Palmitic acid in *Pandanus* oil also can be used as a coating agent in manufacturing nanoparticles, nucleating agents for polypropylene films for microwaveable packaging, edible films, and as a microcapsule material [22–25]. Likewise, linoleic acid in Pandanus oil can be used as a coating agent, especially in the final crystallization phase of magnetite nanoparticles [26]. PUFAs such as oleate and linoleate can also prevent oxidative stress reactions in the recovery of frozen sperm of Ongole bulls [27].

Research on the fatty acid composition of *Pandanus* oil shows its enormous potential. In addition to being recognized as nutrients that provide energy, fatty acids also function as metabolic regulators, which have several advantages for human health. The oil has multifaceted properties like antioxidant, antidiabetic, etc. The oil with antioxidant and antidiabetic properties can be used as health beneficial food ingredients or supplements. Additional clinical trials and product development are required to establish the biological activities of *Pandanus* in humans, based on the biological activities of the plant observed in animals. For continued development, it is imperative to identify the chemical ingredients.

The study's finding show that the fatty acid profiles of the oils derived from *P. iwen* and *P. jiulianettii* are distinct, with the potential for diverse applications. In addition to its nutritional profile, the *Pandanus* plant has also been recognized for its potential as a sustainable and environmentally-friendly source of edible oil. Unlike oil palm, which has been associated with deforestation and habitat loss, the *Pandanus* plant is native to coastal regions and can be cultivated without significant ecological impact.

The development of edible oil from *Pandanus* presents an opportunity to diversify the global food system and address the challenges of food security, biodiversity loss, and climate change adaptation. By exploring the potential of underutilized plant species like *Pandanus*, researchers and policymakers can work towards a more sustainable and resilient food future [28, 29].

5 Conclusions

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The fatty acid composition of *Pandanus iwen* and *Pandanus jiulianettii* seed oils from the Lanny Jaya District in Papua was analyzed. Both oils contained eleven different fatty acids, with *Pandanus iwen* having higher levels of both saturated and unsaturated fatty acids compared to *Pandanus jiulianettii*. The potential applications of these oils include use in the food industry as cooking oil or as ingredients in processed foods, due to their beneficial fatty acid profiles. Moreover, the oils have potential for non-food applications in cosmetic and personal care products due to their antioxidant properties. Overall, the fatty acid profiles of these *Pandanus* oils suggest diverse potential uses in various industries, making them valuable resources for commercial development.

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