



Pre-Design of Virgin Coconut Oil Production Unit from Coconut Fruit (*Cocos Nucifera L*) for An Integrated Coconut Processing Factory

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ABSTRACT

Virgin Coconut Oil is a product derived from coconuts and has a high selling value. Banyuwangi Regency is the second largest producer of coconuts in East Java Province after Sumenep Regency. Determining the location of the factory is located in Banyuwangi Regency, Kabat District, East Java with a total of 84 employees and requires a land area of 1,750m². The VCO production unit factory has working hours 24 hours/day and 330 working days a year. In designing the VCO production unit, the raw material capacity used is 6,000 kg of coconut meat per day and the production capacity to be produced is 1,250 liters/day. The method used is the inducement method, taking into account the quality of the VCO produced, the shelf life, the machinery and equipment used, the low energy consumption, and the short manufacturing time. The required water utility unit is 3,970 liters/day and electricity is 388.5 KWh. Based on the results of the financial analysis, the value of production costs (BP) was IDR 1,968,230,500, the determination of the Cost of Production (HPP) was IDR 57,258, with a profit margin of IDR 22,903, and the selling price (P) of IDR 80,000 / liter, operating results of IDR 2,700,000,000, production profit generated IDR 731,769,500, variable cost per unit IDR 34,545, BEP unit (Q) reaches the breakeven point when sales volume reaches 25,649 liters or BEP (IDR) on sales of IDR 620,341,900, while the business efficiency value (R/C Ratio) obtained is 1.5, so in this case the business is feasible to develop because the business efficiency value obtained is > 1, then the payback period value obtained is 1.1 years or experience a return at 13 months 2 days.

Keywords: Coconut Fruit, Coconut Flesh, VCO, Technical Feasibility Analysis, Financial Feasibility Analysis

1. INTRODUCTION

The opportunity to develop coconut products has very high economic value. One of the high-value derivatives of coconut products is Virgin Coconut Oil or pure coconut oil. This can be seen from the distribution of coconuts in Indonesia. East Java was ranked 3rd during 2019-2022 as the largest coconut-producing region in Indonesia. Meanwhile, Sumenep Regency is ranked 1st in producing the largest coconut production in East Java Province in 2021-2022 and Sumenep Regency's coconut production reaches 46,214 tons/year according to the Indonesian Central Bureau of Statistics 2023 [1].

Coconut commodities most of what is processed is coconut meat, apart from that, in several places various processed coconut products have been developed and used as their by-products. The main product developed from the integrated coconut industry is virgin coconut oil. Pure coconut oil is a processed product that has high value but has not been widely developed in Indonesia. The benefits of pure coconut oil itself are numerous. Previous research results show that using pure coconut oil can increase the body's resistance to deadly diseases. Pure coconut oil has anti-viral properties in the form of lauric acid. Apart from lauric acid, pure coconut oil also contains capric acid or fatty acids which have strong anti-microbial properties [2]. The conventional process of processing virgin coconut oil

usually uses large energy consumption so the process is inefficient. Large energy consumption is used during the process of drying coconut meat into copra. Through the use of appropriate technology and the application of basic process optimization principles, conventional coconut processing can be improved so that the quality produced can be improved [3]. The integrated processing of pure coconut oil is associated with a much shorter processing process, low energy consumption, and high added value of the product produced [2]. To build an integrated coconut oil factory, a feasibility study is needed which can assess the feasibility of a project from various aspects.

Feasibility studies are carried out to avoid and identify future problems in the virgin coconut oil industry to minimize the possibility of missing results and goals to be achieved as well as guidelines or directions for designing virgin coconut oil factories. The purpose of this feasibility study is to examine the design of the virgin coconut oil industry from various aspects, such as technical aspects and financial aspects. The benefits of the feasibility study are to avoid the risk of failure and losses from technical and financial aspects in the future, as well as facilitate the implementation of work in the virgin coconut oil industrial center.

2. DESIGN METHOD

2.1 Technical Feasibility Analysis

Technical aspects are aspects relating to the technical operation and development process of a project after the project/business has been completed/established. Based on this analysis, it can also be seen the initial design for estimating investment costs, including startup costs/pre-operational costs for the project to be implemented [4]. Technical aspects relate to unit operations, 16 production processes, production characteristics, production systems, business systems and location of production units [5]. Technical analysis is an activity to find alternative technologies that are most appropriate for producing goods or services in accordance with investment plans. This aims to select alternatives whose technology has been considered in order to avoid using technology that is not in accordance with the objectives of the project to be built [6]. Several things analyzed in technical aspects include:

1. Company/Factory Location

Location is an important factor for a company because it can influence the development and survival of the company. There are two important things that underlie location selection, namely long-term commitment and the effect on operating costs and income. Mistakes in choosing a company location can also result in high transportation costs, labor shortages, lost opportunities to compete, insufficient raw materials available, or similar things that disrupt the company's smooth operations [7]. In designing the Virgin Coconut Oil production unit factory, the method used to determine location points is the Factor Rating Method. This method is used by considering several factors such as the availability of raw materials, location close to sources of raw materials, and can help local communities create employment opportunities to avoid or reduce the number of unemployed.

2. Specifications for Raw Materials and Products

Raw materials are the main ingredients needed to carry out the production process until it becomes a finished product. Raw materials include materials owned by the company and used for the production process [8]. Product specifications are a complete description of the product. This picture cannot be determined entirely by producers, but should involve consumers [9]. To produce products of good quality, the products must be designed or processed in accordance with applicable standards.

3. Production Capacity

Production capacity is one of the important benchmarks in a company. Production capacity is the number of products that a company should be able to produce in order to achieve maximum profits. Determining production capacity is influenced by several factors such as working hours, number of workers, and so on [10]. In the design of the Virgin Coconut Oil unit factory, 6000 kg of coconut meat is used to produce Virgin Coconut Oil. Generally, the weight of 1 coconut is around 1-1.2 kg and there is 0.32 kg of coconut flesh. In order to produce 1 liter of Virgin Coconut Oil, 10-15 coconuts are needed.

4. Production Process

The production process is a form of activity that is most important in the implementation of production in a company, this is because the production process is a method or method of how the activity of adding benefits or creating benefits is carried out [11]. Making Virgin Coconut Oil can be carried out in 4 methods, including the method of inducement, centrifugation, fermentation, and heating. Generally, when making Virgin Coconut Oil, coconuts that are quite old are grated and then squeezed to extract the coconut milk. This coconut milk can then produce a product in the form of Virgin Coconut Oil.

5. Equipment and Machines used

Selection of the equipment and machines used is important, because errors in selecting the machines and equipment used will cause long-term losses. According to Wijoyo [12], there are several things that need to be considered when selecting machines and equipment, including suitability with technology, acquisition price, capabilities, availability of suppliers, availability of spare parts, quality and economic life.

6. Utility

Utilities are all building supporting equipment and infrastructure which includes comfort, convenience and speed for building occupants [13]. Process support units or utilities must be able to run a factory well from the initial stage to the final stage. In general, utilities include water supply and treatment units, electricity supply units, and so on. The purpose of the process support unit or utility plays an important role in running a factory because it is to support the process so that the factory can run well.

7. Determination of Factory and Building Layouts

Factory layout is a form of placement of facilities used in the production process. The layout is determined when the business location (factory) is determined with various considerations. A good layout has criteria such as minimizing transport distances between parts, good material flow, effective use of space, flexibility and beauty, providing safety for machines and equipment, allowing for expansion, minimizing production costs, and providing safety guarantees for the workforce.

8. Labor

Labor is the main resource for the continuity of production in a company. The presence of labor is very necessary, especially in production processes where the level of productivity requires a level of efficiency in the process [14]. The greater the number of workers available, the greater the things that need to be considered, such as their security as workers. Labor is the most important factor in the production process. As a production suggestion, labor is more important than other means of production such as raw materials, land, water, and so on [15].

2.2 Financial Feasibility Analysis

The financial aspect is an aspect that is used to assess the finances of a company as a whole. The financial aspect is as important as any other aspect. The financial aspect refers to a picture related to the profits of a company, so it can be said that the financial aspect is a very important aspect to examine for its feasibility [16]. In the financial aspect, the important aspects to analyze include the source of funds, use of funds, cost projections, income projections, profit projections and cash flow projections [17]. The following are the calculation aspects analyzed in the financial aspect:

1. Cost of Goods Produced (COGS)

Cost of goods produced is the total production cost of goods that have been completed and transferred into the inventory of finished goods during a month period. Cost of goods produced consisting of direct raw materials, direct labor, and factory overhead costs which are added to the inventory of products in the initial process and reduced by the inventory of products in the final process [1]. Cost of goods produced is calculated using the following calculation formula [18]:

$$\text{COGS} = \frac{BP (FC + VC + BO)}{PT} \quad (1)$$

Detail:

COGS : Cost of Goods Produced

BP : Production Cost

FC : Fixed Cost

VC : Variable Cost

BO : Cost of Overhead

PT : Products produced for a month

2. Determination of Selling Price

Determination of Selling Price is calculated using the following calculation formula:

$$\text{Profit Margin} = 40\% \times \text{COGS} \quad (2)$$

$$\text{Product Selling Price} = \text{COGS} + \text{Profit Margin} \quad (3)$$

3. Calculation of Production Profit

The calculation of production profit is calculated using the following calculation formula:

$$\text{Result of Efforts} = \text{Production amount} \times \text{Number of days production} \times \text{Product selling price}$$

Production profit = Results of Efforts – Production Cost

4. Break Even Point (BEP)

Break Even Point is calculated using the following calculation formula:

$$\text{Variable Costs/Unit} = \frac{VC}{\text{capacity per day} - \text{number of days of production}} \quad (4)$$

Detail:

VC : Variable Cost

$$\text{BEP Value of the Unit (Q)} = \frac{VC}{\text{Product Selling Price (P)} \times \text{Variabel Cost per Unit}} \quad (5)$$

$$\text{BEP(Rp)} = \frac{FC}{1 - \frac{\text{Variable Cost per Unit}}{\text{Selling Business Results}}} \quad (6)$$

Detail:

FC : Fixed Cost

5. Business Efficiency (R/C Ratio)

Business Efficiency is calculated using the following calculation formula:

$$R/C = \frac{\text{Result of Efforts}}{FC+VC} \quad (7)$$

Detail:

FC : Fixed Cost

VC : Variable Cost

-R/C Ratio > 1 The business that is run is profitable / worth developing.

-R/C Ratio < 1 The business suffered a loss / was not worth developing.

-R/C Ratio = 1 Business is breaking even (Break event Point)

6. Payback Period

Payback Period is calculated using the following calculation formula:

$$\text{Payback Period} = \frac{\text{Fixed Capital}}{\text{Result of finished efforts}} \times 1 \text{ year} \quad (8)$$

- If the payback period is smaller than the target return on investment, then the investment project can be said to be feasible

- If the payback period is greater than the target return on investment, then the project is said to be not feasible

3. RESULT AND DISCUSSION

3.1 Technical Feasibility Analysis

1. Location Determination

Determination of the location of the virgin coconut oil production unit is determined by considering several factors, such as the availability of raw materials, namely coconuts, and locations close to the availability of raw materials. East Java is the province with 3rd place as the province with the largest coconut producer in Indonesia by 9.17% in 2016-2020. Based on data obtained by the Central Statistics Agency (BPS) for 2021-2022, the districts with the largest coconut producers in East Java are Sumenep with 45,583-46,214 tons/year, Banyuwangi with 35,244-34,996 tons/year, and Blitar with 21,095-21,185 tons/year. The method used to determine the location of the coconut shell charcoal briquette production unit uses the Factor Rating Method. Determining the location of the Factor Rating Method has an assessment of criteria for each factor on a scale of 1-100. The data from each region can be seen in **Table 1.** and the results of data processing for determining location using the factor rating method can be seen in **Table 2.**

Table 1. Data from Each Region

No	Factor	Kab. Sumenep	Kab. Banyuwangi	Kab. Blitar
1	Availability of Raw Materials *	46.214 ton	34 996 ton	21 185 ton
2	Utility	PLN and PDAM	PLN and PDAM	PLN and PDAM
3	Location expansion *	545 inhabitant /km ²	301 inhabitant /km ²	786 inhabitant /km ²
4	UMK	IDR 2.176.819	IDR 2.528.899	IDR 2.215.071
5	Land Price	Rp600.000-850.000	IDR 383.000-950.000	Rp375.000-1.100.000

Table 2. Results of Data Processing for Determining Location Using the Factor Rating Method

No	Factor	Weight (B)	Kab. Sumenep		Kab. Banyuwangi		Kab. Blitar	
			Value (N)	Score (BxN)	Value (N)	Score (BxN)	Value (N)	Score (BxN)
1	Availability of Raw Materials	0,30	100	30	100	30	75	22,5
2	Utility	0,25	100	25	100	25	100	25
3	Location expansion	0,15	75	11,25	100	15	75	11,25
4	Land Price	0,20	100	20	100	20	75	15
5	UMK	0,10	100	10	75	7,5	100	10
Total		1,00		96,25		97,5		83,75

The results of the calculation of determining the location of the Virgin Coconut Oil production unit using the Factor Rating Method method obtained the highest score for Banyuwangi Regency with 97.5, followed by Sumenep Regency with 96.25, and Blitar Regency with 83.75. Based on the BPS in 2022, the area of coconut plantations in Banyuwangi district is 34,647 ha, while the production capacity per year 2022 Banyuwangi Regency produces coconuts is 34,996 tonnes/year. Banyuwangi Regency itself is the second largest coconut producing district in East Java province. In Banyuwangi Regency, the biggest coconut producers are in Kabat District, Rogojampi District, and Sempu District. The determination of the location point for the Virgin Coconut Oil production unit is based on factors determining the location in Banyuwangi Regency, Kabat District. The following is a map of the location of Banyuwangi Regency, Kabat District, which can be seen in **Figure 1**.

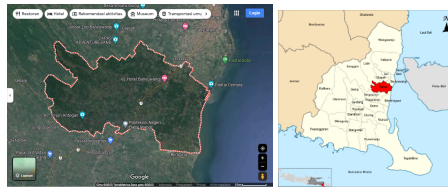


Figure 1 Location Map of Banyuwangi Regency, Kabat District

2. Specifications of Raw Materials and Products

Raw materials are the main ingredients needed to carry out the production process until it becomes a finished product. Raw materials include materials owned by the company and used for the production process [8]. Product specifications are a complete description of the product. This picture cannot be determined entirely by producers, but should involve consumers [9]. To produce products of good quality, the products must be designed or processed in accordance with applicable standards. The following are specifications for VCO raw materials in the form of coconut, coconut milk, as well as the final product in the form of VCO.

a. Coconut

Fruit Age	: 12-13 Month
Form	: Congested
Storage Time	: not past 7 days of harvest
Fruit Condition	: intact, not broken or cracked and has not formed gandos (haustorium)

Coconut Composition

Water	: 23%
Meat	: 30%
Shell	: 12%
Viber	: 35%

b. Coconut Cream

Energy	: 324kkal
Protein	: 4.2 gr
Carbohydrates	: 5.6 gr
Fat	: 34.2 gr
Calcium	: 14 mg
Phosphorus	: 45 mg
Iron	: 2 mg
Vitamin B1	: 0.02 mg
Vitamin C	: 2 mg

c. Virgin Coconut Oil has the following product specifications

Form	: Liquid
Smell	: Not rancid like fresh coconut
Taste	: Special like coconut oil
Color	: Colorless to pale yellow
Water content	: max 0.2%
Impurities	: max 0.05%
Number of iodine	: 4.1-11 iodine/100g
Free fatty acids	: max 0.2%
Number of peroxides	: max 2.0 mg ek/kg [19]

3. Production Capacity

In the design of the Virgin Coconut Oil unit factory, 6,000 kg/day of coconut meat is used. Generally, the weight of 1 coconut is around 1-1.2 kg and there is 0.32 kg of coconut flesh. In order to produce 1 liter of Virgin Coconut Oil, 10-15 coconuts are needed. The data analyzed includes the total production of pure coconut oil achieved per day. Pure coconut oil production capacity is determined based on the availability of raw materials, machine and equipment capacity, and workforce. This can be said to be feasible if the production capacity is in accordance with the amount of raw materials, and the capacity of the available machines and equipment. Meanwhile, details of Virgin Coconut Oil production capacity can be seen in **Table 3**.

Table 3. Virgin Coconut Oil Production Capacity

Nu	Capacity	The required amount of coconut meat	Number of VCOs produced
1	Per Day	6.000 kg	1.250 L
2	Per Month	165.000 kg	34.375 L
3	Per Year	1.980.000kg	412.500 L

4. Production Process

In the virgin coconut oil production process, the method used is the lure method by considering the need for raw materials, the quality of the virgin coconut oil produced must comply with SNI 7381:2008, the shelf life of virgin coconut oil, the machines and equipment used, energy consumption during the production process, and the time required in the production process. With the fishing method, the oil molecules in the coconut milk are attracted by the fishing oil, until they finally become oil. This pulling will cause the water and proteins that were previously bound to the coconut milk molecules to become broken. This technique basically changes an oil-water emulsion into oil-oil [20].

5. Equipment and Machines Used

The use of equipment and machinery can be said to be feasible if the types, capacity specifications, and number of machines and equipment used are in accordance with the needs and daily production capacity in the design of virgin coconut oil production units. In this design, the machine and equipment used for the production of Virgin Coconut Oil include fruit washing machines, grating machines and coconut milk presses, VCO filtering machines and automatic filling machines, as well as other supporting equipment and machines.

6. Utility

Utilities or process support units are the supporting facilities needed and needed in factories to support the production stage running well. In the pre-designed VCO production unit, a supporting unit is needed that is able to support process requirements. Utilities are needed to run the production process from the initial stage to the finished product. It can be seen in **Table 4**, which shows the need for water per day and per year used for the needs of the production process and the environment around the factory, and **Table 5**, which shows the need for electricity per day and per year used for the needs of the production process and the environment around the factory.

Table 4. Water Needs per Day and per Year

Nu	Types of Water Needs	Need Water/Day (L)	Need Water/Year (L)
1	Production process water	3.600	99.000
2	Prayer room water	150	49.500
3	Sanitary water	120	39.600
4	Water consumption	100	33.000

Table 5. Electricity Needs per Day or per Year

Nu	Types of Electricity Needs	Electricity Needs/Day(KWh)	Electricity Requirements/Year (KWh)
1	Filling Machine	43.2	14.256
2	Laptops	30	9.900
3	Printers	30	9.900
4	Water machine	88.8	29.304
5	air conditioning	64	21.120
6	Fan	3.2	1.056
7	Room and Non-Room Lighting	129.3	42.680

7. Determination of Product and Building Layouts

Determining the layout of the factory and building includes production space (raw material room, coconut meat washing room, VCO manufacturing room, VCO filtering room, QA room, QC room, packaging room, VCO storage room), and non-production space (office, prayer room, canteen, security guard, workshop room). Determining a good factory layout has criteria including minimizing transport distances, good material flow, effective use of space [21]. The layout of the VCO production unit consists of 9 separate rooms and has an area of 20 x 30 m, and 5 non-production rooms, with a total area of 35 x 50 m. The factory and building layout plan can be seen in **Fig. 2**.

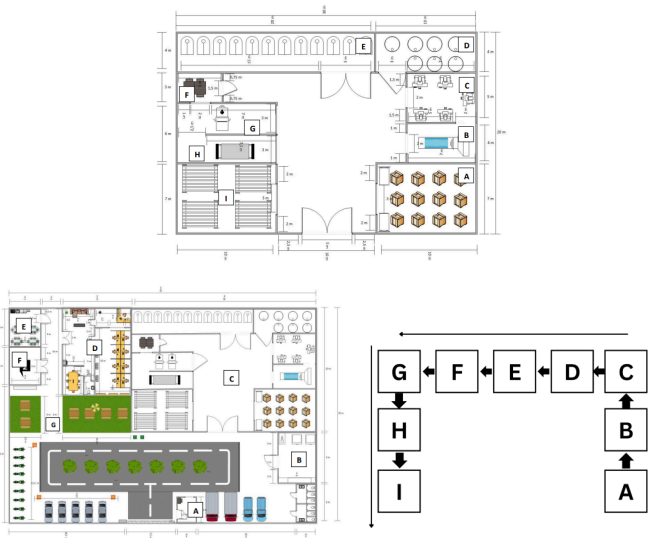


Figure 2 Factory and Building Layout Plans

8. Workforce

Labor is an important factor in building a business. A business can develop well if it is supported by several factors. One of the factors that supports the development of a business is the existence of human resources placed in areas of work that are tailored to their respective skills. Laboratory is a very important factor because laboratory supports the continuity of the production process and the operation of machines and equipment in the factory. In this design, there are 84 employees with 330 working days, and are divided into shift employees and non-shift employees.

3.2 Financial Feasibility Analysis

1. Summary of Financial Analysis Calculation Results

The results of the calculation of Financial Analysis for the design for the production of Virgin Coconut Oil include the Cost of Production (HPP) which has a value of Rp57,258, then the Product Selling Price is Rp80,000/liter with a profit margin of 40% and a margin value of Rp22,903. Furthermore, the production profit received every month is IDR 731,769,500. the BEP unit value obtained or VCO unit production reaches a breakeven point if sales volume reaches 25,649 liters and BEP (Rp) reaches Rp620,341,900. The business efficiency value or Return Cost Ratio (R/C Ratio) in the VCO production unit is 1.5 and the Payback Period value obtained is 1.1 years or 13 months 2 days. The summary of the calculation results of financial analysis can be seen in **Table 6**.

Table 6. Summary of Financial Analysis Calculation Results

Nu	Fee Type	The calculation results
1	Working capital	IDR 1.138.500.000
2	Fixed capital	IDR 2.960.833.290
3	Fixed Costs	IDR 620.341.900
4	Non-Fixed Costs (Variable Cost)	IDR 1.165.901.100
5	Overhead Costs	IDR 181.987.500
6	Total Production Cost (BP)	IDR 1.968.230.500
7	Cost of Production (COGS)	IDR 57.258
8	Profit Margins	IDR 22.903
9	Product Selling Price (P)	IDR 80.000
10	Company results	IDR 2.700.000.000
11	Production Profit	IDR 731.769.500

12	Variable Cost Per Unit	IDR 34.545
13	BEP Units (Q)	25.649 liter
14	BEP (Rp)	IDR 620.341.900
15	Business Efficiency (R/C Ratio)	1,5
16	Payback Period (PP)	1,1Year / 13 Month 2 Day

4. CONCLUSION

1. The Virgin Coconut Oil (VCO) production unit factory is designed taking into account technical and financial feasibility. After analyzing these two aspects, it can be stated that designing a VCO production unit using the fishing method has a high opportunity to increase the selling value of processed coconut products, making it suitable for operation.
2. The results of the technical feasibility analysis taking into account several aspects such as determining the location of the factory which is located in Banyuwangi Regency, Kabat District using the Factor Rating Method, the required raw material is coconut meat of 6,000 kg/day. The production capacity is 1,250 liters/day, in the design of the VCO production unit factory the VCO production process uses the lure method, while the equipment and machines used are in the form of a coconut washing machine, grating machine and coconut milk press, oil filter machine, and automatic filling machine. Utility needs in the form of water are 3,970 liters/day and electricity is 388.5 KWh. Determination of the factory layout using the type of product layout (Product Layout) and buildings with a total land area of 1,750m² and a building area of 800m². In the design of the VCO production unit, the required workforce is 84 employees with a working day of 330 days a year, there are shift employees and non-shift employees.
3. Results of financial analysis taking into account several aspects such as the working capital value of IDR 1,138,500,000, fixed capital of IDR 2,960,833,290, Fixed Cost of IDR 620,341,900, Variable Cost of IDR. 1,165,901,100, overhead costs IDR 181,987,500. As for the calculation formula used, such as, the total cost of production (BP) is IDR 1,968,230,500, the determination of the Cost of Production (HPP) is IDR 57,258, with a profit margin of IDR 22,903, and the selling price (P) is IDR IDR 80,000/liter, business results of IDR. 2,700,000,000, production profit generated is Rp731,769,500, variable cost per unit is Rp34,545, BEP unit (Q) reaches breakeven when sales volume reaches 25,649 liters and BEP (Rp) on sales Rp620, 341, 900, while the business efficiency value (R/C Ratio) obtained is 1.5, in this case the business is feasible to develop because the business efficiency value obtained is > 1, then the payback period value obtained is 1.1 years or experiencing a return at 13 months 2 days.

AUTHORS' CONTRIBUTIONS

The authors contributed to this work as follows: Mochamad Bagus Hermanto conceptualized the research study, designed the methodology, supervised the project, provided funding acquisition for the research. Nur Azmi Annastasya Ramdhani designed the methodology, collected and analyzed the data, and initial manuscript, while Wahyunnanto Agung Nugroho supervised the project, analyzed and interpreted the results. All authors contributed to revising, editing the manuscript. All authors have reviewed and approved the final version of the manuscript.

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