VIRGIN COCONUT OIL

NAIP ON VALUE CHAIN IN COCONUT

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
KASARAGOD- 671 124, KERALA

Technical Bulletin No. 61

VIRGIN COCONUT OIL

K. Madhavan
T. Arumuganathan
A. C. Mathew

NAIP ON VALUE CHAIN IN COCONUT
CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
KASARAGOD - 671 124, KERALA.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
KASARAGOD 671 124, KERALA, INDIA
Phone : 04994 – 232893, 232894, 233090
Fax: 91-4994-232322
Email: cpcri@nic.in
Website: http://www.cpcri.gov.in/

VIRGIN COCONUT OIL
CPCRI Technical Bulletin No. 61

Published by
Dr. George V. Thomas
Director
Central Plantation Crops Research Institute
Kasaragod - 671 124, KERALA, INDIA

Text Compiled and edited by
Er. K. Madhavan
Dr. T. Arumuganathan
Dr. A.C. Mathew

Photo Credits and Coverpage
Mr. G.S. Hareesh

2010

Printed at
Codeword Process & Printers
C-18, Yeyyadi, Mangalore – 575 008.
Ph: (0824) 2214618, 9900100818

1. INTRODUCTION

Coconut palm, "The Tree of Life", is known to confer multiple benefits like health, wealth and shelter to mankind. In India, the use of coconut for food and health is documented in Ayurvedic text book since time immemorial. The most popular edible commercial products derived from fresh coconut kernels are desiccated coconut, coconut milk/cream in liquid and powder form and coconut oil. One of the primary natural products produced from the "tree of life" is coconut oil which has been used for thousands of years as food and cooking oil. Coconut oil is used for various purposes i.e. edible (39.4%), toiletry (46.5%) and other industrial (14.1%) uses. In the recent past, the coconut oil has been used as a food ingredient in functional foods, besides being used in pharmaceuticals, nutriceuticals, cosmetics and industrial uses including biofuel. Coconut oil is a rich source of medium-chain-triglycerides (MCT) which are beneficial for human health and nutrition. Sixty three percent of coconut oil is composed of antimicrobial medium-chain fatty acids and therefore can assist the immune system in fighting against microscopic invades. Coconut oil is rich in free fatty acids viz., lauric acid, capric acid, caprylic acid and caproic acid which makes up triglyceride molecule and forms antimicrobial properties of the coconut oil. MCT's found in coconut oil have been shown in laboratory experiments to be effective in destroying viruses, bacteria, yeasts and parasites. The recent high value coconut product, which is becoming popular globally, is Virgin Coconut Oil (VCO).

VCO is the oil obtained from fresh, mature endosperm (kernel-meat) of the coconut by mechanical or natural means, with or without use of heat, no chemical refining, bleaching or de odorizing and maintains the natural aroma and nutrients. It is called "virgin" because the oil obtained is pure, raw and pristine. Virgin coconut oil is suitable for human consumption in its natural form. It is the purest form of coconut oil, crystal clear, contains natural vitamin E and with very low, free fatty acid content (0.1 %). It has a fresh coconut aroma ranging from mild to intense depending on extraction process.

2. HEALTH BENEFITS OF VCO

Virgin coconut oil is considered as nutraceutical food, because

- The medium chain (C8-C12) fats in coconut oil are similar in structure to the fats in mother's milk that gives babies immunity to disease
- VCO possess anti-inflammatory, anti microbial and anti oxidant properties, which work together to protect arteries from artherosclerosis and the human heart from cardiovascular disease
- VCO boosts the immune system
- VCO protects against heart disease by increasing high-density lipoprotein (HDL) that collects the excess or unused cholesterol in the body for excretion by the liver

- VCO provides protection from infectious diseases not easily cured by known antibiotics
- VCO is digested easily and does not require pancreatic digestive enzymes and bile and goes directly to the liver for conversion into energy
- VCO stimulates metabolism, boosts energy and prevents deposition of fats thereby preventing obesity
- VCO improves the nutritional value of food by increasing absorption of vitamins, minerals and amino acids
- VCO is main base in cosmetics products which provide skin health.

3. USES OF VCO

Coconut oil has several industrial applications. But VCO is unique among all the other vegetable oils because of its high lauric acid content. It is reported that lauric acid in coconut oil is used by the body to make the same disease fighting fatty acid derivative monolaurin that babies make from the lauric acid they get from mother's milk. The monoglyceride (monolaurin) is the substance that keeps infants away from getting viral or bacterial or protozoal infections. The other common applications of VCO are given below. It is used as

- Hair and skin conditioner
- Oil base for various cosmetic and skin care products
- Carrier oil for aroma therapy and massage oils
- Nutraceutical and functional food

4. PROCESSING VIRGIN COCONUT OIL

Virgin coconut oil can be extracted directly from the fresh coconut meat or from coconut milk. The different processes involved in VCO production are Hot-processing method, Natural fermentation method, Centrifugation process and extraction from dried grating (EDG) method. The choice of the technology to be adopted depends to a great extent on the scale of operation, the degree of mechanization, the amount of investment available and the market demand. For decades, people in coconut producing countries like India and Philippines boiled coconut milk extracted from freshly grated or comminuted (grated, chopped, granulated) coconut meat with or without the addition of water, to produce coconut oil for hair and body massaging applications.

The modified hot process method for producing VCO also follows the same principle except for controlled heating to prevent the oil from turning yellow and maintain the moisture content less than 0.2 % to prolong its shelf life. Hot process comprises of two stages; extraction/ preparation of coconut milk and cooking the milk to get VCO.

In fermentation method, the VCO can be produced in a home-scale operation using ordinary kitchen utensils after extracting the coconut milk. The oil produced in this method is water-clear in colour. The VCO produced could turn sour if the fermentation period is prolonged and

the fermentation process conditions are not controlled properly. Fermentation method comprises of two stages; extraction/ preparation of coconut milk and fermentation of the milk for VCO production.

In centrifugation method, the coconut milk is subjected to mechanical phase separation process. Coconut milk and hot water is fed in a three-way centrifuge equipment where the oil separates out from the top and the water and sludge comes out through separate outlets. It produces the best quality oil with sweet coconut aroma and the oil produced in this method is water-clear in colour. Centrifuge method comprises two stages; extraction/ preparation of coconut milk and centrifugation of the milk for VCO production.

Important steps involved in the production of virgin coconut oil are given in Figure 1 as process flow chart and each process involved in VCO production are discussed in detail.

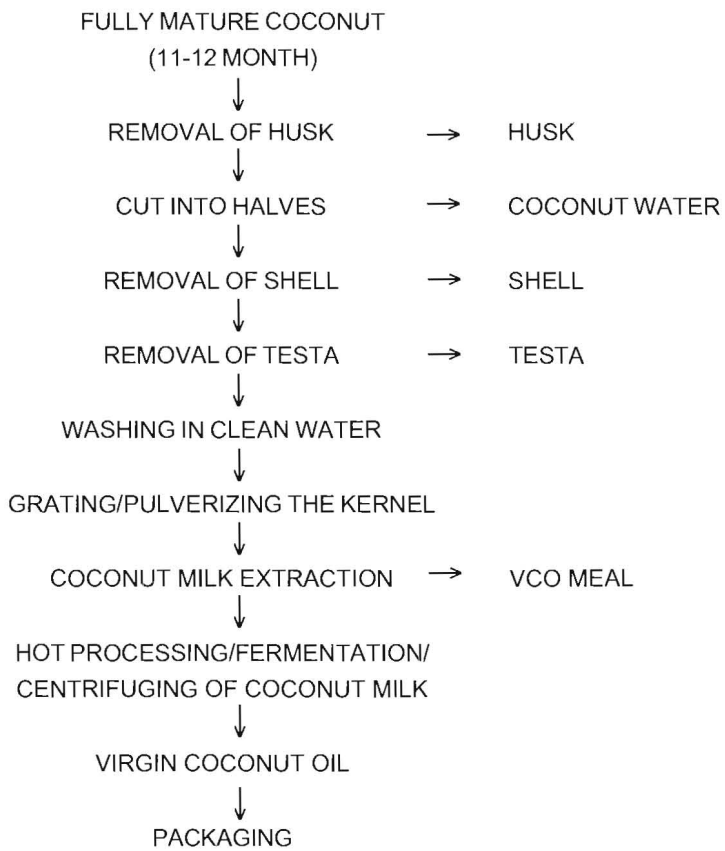

Fig. 1. Process flow chart for the production of virgin coconut oil

5. PROCESS FOR THE EXTRACTION AND PREPARATION OF COCONUT MILK

5.1. Selection of nuts

Fully mature 11-12 month old nuts are selected for VCO production. As an indicator of maturity of the nut, the husk will be yellowish to brown in colour and makes a sloshing sound when shaken.

5.2. Removal of shell

By using a special type of tool, the shell is removed without breaking the coconut kernel, which helps for easy removal of the testa. The shell can also be removed after breaking the coconut into halves and then scoop out the kernel pieces by knife (Fig. 2). But it will increase the time required for removing the testa.

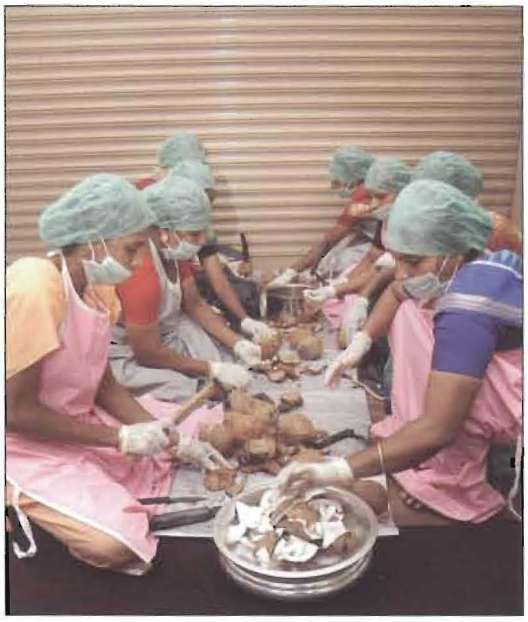

Fig. 2. Deshelling of coconut

5.3. Removal of testa

The testa of the coconut kernel has to be removed for getting water colour virgin coconut oil. For the purpose, a peeler can be used and the testa can be removed manually (Fig. 3). Care should be taken to peel the testa only, without affecting the white kernel.

Fig. 3. Manual removal of testa

The testa can also be removed using the testa remover machine developed at CPCRI, Kasaragod. The testa remover machine is shown in Figure 4.

Fig. 4. Testa removal using testa remover

5.4. Grating of kernel

The coconut meat, free from testa, is fed to a mechanical grating machine (Fig. 5). Alternatively coconut may be grated manually using a coconut grating machine (Fig. 6). Here the coconut cups, after splitting coconut into two halves, are pressed manually to the rotating blade of the machine for grating. Care should be taken to grate the meat without adhering testa.

Fig. 5. Mechanical Coconut grating machine/Coconut pulverizer

Fig. 6. Manual Coconut grating machine

5.5. First milk extraction

Coconut milk is extracted from the grated coconut meat manually using manually operated hydraulic coconut milk press (Fig. 7). The coconut milk obtained from the first extraction is collected separately and the residue is utilized for second extraction.

Fig. 7. Coconut milk extractor

5.6. Second milk extraction

Second milk extraction is carried out by mixing warm water (250 ml/kg of residue) to the residue and the rest of the process is same as above.

5.7. Third milk extraction

Third milk extraction is carried out by mixing warm water (250 ml/kg of residue) to the residue of the second milk extraction and the rest of the process is same as above. Third milk extraction is recommended for fermentation method and it will not be economical for hot processing and centrifuging methods.

5.8. Mixing

Pool the first, second and third milk extracts by stirring vigorously for few minutes.

6. HOT PROCESS FOR PROCESSING OF COCONUT MILK TO PRODUCE VCO

6.1. Settling of the coconut milk

Coconut milk is an emulsion of oil and water that is stabilized by protein. To recover the oil from coconut milk, the protein bond has to be broken either by heat or by enzymes or some other mechanical means. The extracted coconut milk is allowed to stand for maximum three hours. If the settling is done in the refrigerator or in ice box, coco skim milk, a very nutritious beverage containing protein and other nutrients like calcium, potassium, phosphorus, niacin, thiamine and riboflavin, can be recovered for human consumption. Settling the coconut milk at ambient temperature turns the skim milk sour and unsuitable for human consumption.

6.2. Separation

Separate the cream (oily part) from the coco skim milk (aqueous part) by scooping the cream from the top. Coco skim milk can be preserved for processing further into beverage.

6.3. Slow heating of the coconut cream

If the coconut milk is directly used in slow heating process it will take a much longer heating time to recover oil. Coco cream is placed in a double walled boiler known as VCO cooker developed at CPCRI under slow heat to coagulate the protein and release the oil. After slow heating for about 2 to 2.5 hours, coconut cream will start to coagulate and separate out the oil (Class A oil). For the first hour of heating, temperature can be allowed to reach 120°C. Further the temperature is brought down to 90°C until the protein begins to coagulate and the temperature is reduced to 60°C when the oil starts to separate. The hot processing of coconut milk in VCO cooker designed and developed at CPCRI, Kasaragod is shown in Figure 8.

Fig. 8. Hot processing of VCO in VCO cooker

6.4. Separation

Separate the class A oil from the proteinacious residue (kalkam) by straining the mixture through a muslin cloth or stainless steel mesh. The remaining kalkam can be further slow heated to recover more oil (Class B oil). However, this type of oil, class B oil, is yellow in colour and is suitable for skin care or massage products.

6.5. Drying

Drying is required to ensure that all residual moisture is removed to prolong the shelf life of the VCO. Drying of the oil can be achieved by placing the extracted oil in a double walled boiler at 50°C for fifteen minutes or until the turbid oil become crystal clear.

6.6. Filtration

Oil is again filtered to remove the adhering fine particles of kalkam, if any, that has passed through the muslin cloth. Under small scale, the oil is filtered through sterilized cotton wool and for large-scale operation, a fabricated pressure filter with filter cloth is recommended to increase the filtration rate.

7. FERMENTATION PROCESS FOR PROCESSING OF COCONUT MILK TO PRODUCE VCO

Coconut milk extracted from the grating as explained above is allowed to stand for 20-24 hours. Under favourable conditions, the oil naturally separates from the water and the protein. The air borne lactic acid bacteria, which has the capability to break the protein bonds, act on the coconut milk mixture causing the VCO separation.

7.1. Settling of the coconut milk in fermentation tank

After the coconut milk is placed in the settling/fermentation container, it must be covered with a loose fitting cloth to prevent aerial contamination by yeast, moulds or bacteria. A fermentation temperature of around 35-40°C is to be maintained in the area where the fermenting container is placed. Relative humidity within the area should also be maintained at a maximum of 75%. A small electric heater with built-in thermostat control can also be installed in the fermentation cabinet. Under these conditions a fermentation time of 20-24 hours results in a relatively high yield (16-18%) of fine quality VCO.

To fasten the fermentation process, skim milk at the rate of 30 ml per litre of coconut milk is added to the coconut milk mixture before the start of the fermentation process. This will not only fasten the fermentation process (16-18 hours) but also results in comparatively high recovery (18-20%) of VCO. This technique will also reduce the quantity of floating fermented curd which is normally found in the top layer after the fermentation process.

7.2. Separation

The fermenting container should be made up of food-grade, transparent plastic. It should be wide-mouthed for easy removal of fermented curd. The fermenting container can also be a food grade stainless steel cylindrical tank with a conical bottom with outlet tap specified and a sight glass to see the different layers as the oil separates. Oil can be withdrawn from the outlet tap based on the levels shown in the sight glass. The fermentation container with VCO and skim milk is shown in Figure 9.

If proper operating conditions and sanitary precautions are strictly followed, four distinct layers can be seen in the

Fig. 9. Fermentation tank for producing VCO by fermentation method

fermenting container after settling for 16 hours. The bottom layer is made up of gummy sediment. The next layer is the watery, fermented skim milk that is no longer fit for human consumption. The next layer is the separated oil for recovery as VCO. The top layer is floating fermented curd. The fermented curd also contains a considerable amount of trapped oil. By carefully separating the distinct layers, the oil can be separated.

7.3. Filtration

The separated oil contains some adhering particles of fermented curd and it needs to be filtered before drying and packing. Under small scale, the oil is filtered through sterilized cotton wool or filter paper or filter cloth placed in the hole of a big funnel and allowing it to trickle down and for large-scale operation, a pressure filter with filter cloth is recommended to increase the filtration rate.

7.4. Drying

Drying is required to ensure that all residual moisture is removed to prolong the shelf life of the VCO. Drying of the oil can be achieved by placing the extracted oil in a double walled boiler at 50°C for fifteen minutes or until the turbid oil become crystal clear. Oil drying temperatures should not exceed 65°C otherwise that will result in slight yellow colour oil which is classified as class B oil. Apart from removing the residual oil, heating the VCO will ensure that fermentation is stopped. It will also remove the fermented sour smell from the oil to some extent.

7.5. Heating of fermented curd

After VCO separation, the fermented curd is heated to recover the residual class B oil which can be used for making skin care products and soap. The temperatures are not as strictly controlled but should not exceed 90°C as the oil will become dark yellow.

8. CENTRIFUGATION PROCESS FOR PROCESSING OF COCONUT MILK TO PRODUCE VCO

Coconut milk is the natural oil-in-water emulsion extracted from the endosperm of coconut. It contains fat, water, carbohydrate, protein and ash with the major components water and fat. The emulsion is naturally stabilized by coconut proteins: globulins, albumins and phospholipids. However, the coconut milk emulsion is unstable and readily separates into two distinct phases - a heavy aqueous phase and a lighter cream phase. The reason for the instability is that the protein content and quality in coconut milk is not sufficient to stabilize the fat globules. The centrifuge works on the sedimentation

principle, where the centripetal acceleration is used to separate substance of greater and lesser density. By using a centrifuge, it is possible to break down emulsions and to separate dispersions of fine liquid droplets for recovering the oil from coconut milk.

8.1. Preparing coconut milk mixture for centrifugation process

The extracted coconut milk is subjected to cooling in refrigerated condition for two hours and this will enhance the oil recovery. To fasten the oil recovery process, the cooled coconut milk is mixed with good quality water at the ratio of 1:1.5. Now the coconut milk mixture is ready for centrifugation process.

8.2. Clarification

The prepared coconut milk mixture is subjected to clarification process in the clarifier (Fig. 10) attached to the centrifuge. The oil mixture is filtered through 200 micron size filters and the filtered/clarified coconut milk mixture is collected to the feed tank.

Fig. 10. Clarifier

8.3. Separation

Before pumping the clarified milk mixture into the centrifuge bowl, good quality water is pumped to the centrifuge bowl for five minutes to clean and wash the bowl. The clarified milk mixture in the feed tank is then pumped to a centrifuge and subjected to very high speed in the range of 15000 rpm. Due to centrifugal acceleration the separation of oil from the emulsion takes place and oil and water will come out through separate outlet. This is considered as one cycle and the collected water will be again fed to the feed take and pumped again to centrifuge for oil separation. Likewise three cycles are involved for extracting oil from one batch of coconut milk mixture. The view of the centrifuge can be seen in the Figure 11.

Fig. 11. Centrifuge

8.4. Drying

Drying is required to ensure that all residual moisture is removed to prolong the

shelf life of the VCO. Drying of the oil can be achieved by placing the extracted oil in a double walled boiler at 50°C for fifteen minutes or until the oil become crystal clear from turbid. Oil drying temperatures should not exceed 65°C otherwise that will result in slight yellow colour oil which is classified as class B oil.

9. PACKAGING AND STORAGE OF VCO

· VCO can be stored in stainless steel containers and poly-lined drums. However, for long-term storage, the recommended packaging material for VCO is glass. PET bottles can be used for day-to-day use. The packaging material should be very dry before filling the oil in it. Figure 12 shows the virgin coconut oil prepared by all the three methods and packed in PET bottle. The ideal quality characteristics of the VCO are given in Table 1.

Fig. 12. Virgin Coconut Oil packed in PET bottle

Table 1. Ideal quality characteristics of VCO

Properties	Specification
Colour	Water-clear
Free fatty acid (as lauric acid)	< 0.1 %
Moisture (matter volatile at 105°C)	< 0.1 %
Peroxide value	< 3
Lauric fatty acid content	47-55 %
Aroma	Fresh coconut, mild to intense

10. CRITICAL CONTROL MEASURES

Coconut milk contains protein and other nutrients and has high moisture content and nutrients making it more susceptible to microbial contamination and rapid spoilage. Because of these characteristics, grating or milling of fresh coconut meat and subsequent extraction of the milk should be done in a clean environment and under strict sanitary conditions. The following critical control measures are to be followed while preparing VCO.

- Wash hands with soap and water before doing any preparation work and wear the necessary protective clothing with hair cover.
- Ensure that all materials, utensils or equipment used in extracting and holding coconut meat and milk are thoroughly cleaned and rinsed with hot water. Utensils should be free from any soap or chemical residue.
- Always ensure that grating or scraping of coconut meat and subsequent milk extraction is done under clean conditions by observing good personal hygiene.
- High quality clean water should be used for second milk extraction.
- VCO should not be heated in a pan on direct heat as this will cause the oil to turn yellow.
- Precise controls for the maturity of coconuts and the ambient conditions for the fermentation room are necessary to obtain good and high quality VCO recovery.
- Fermentation method is very sensitive to the maturity and freshness of the nuts. Immature nuts contain a high percentage of protein which makes the protein bonding in coconut milk much more difficult to break and release the oil. Likewise, if the coconuts are stored for longer period, the risk of spoilage and contamination will be higher.
- In Fermentation method, occasionally the coconut milk mixture that is left for 16 to 24 hours will generate big bubbles and no oil will be separated. The major cause of the bubbling problem is contamination, either through soap residues in the fermenting container or invasion of micro-organisms. If this occurs, immediately transfer the creamy layer to the evaporating pan and heat the contents so that oil can be still recovered. However, this oil will be considered as Class B oil and should only be used for making some skin care products and soap. It is not suitable for human consumption.

11. UTILIZATION OF BY-PRODUCT

VCO meal is the by-product of the VCO process based on coconut milk. The residue represents approximately 25-50% of the weight of freshly grated meat on a wet basis, depending on the coconut milk

extraction process used. The VCO meal usually retains about 35-40% of the original oil content of the fresh coconut meat and is very rich in dietary fibre (about 32%). VCO meal can be utilized in various ways and the different uses are listed below:

- It can be used for preparing fortified atta. Adding VCO meal to atta fortifies the food product with dietary fibre, protein and fat essential for good nutrition.
- As an ingredients it can be used for making many value added products namely VCO meal *laddu,* biscuits, *halwa,* porridge etc. When using VCO meal for biscuits, by partially substituting wheat flour, the cost is reduced and the nutritional value of the product is enhanced by way of dietary fat and fibre.
- If VCO processing is carried out under strict sanitary conditions, the VCO meal can be sold as high quality animal feed ingredient.

Another by-product of this process is coconut skim milk which is a nutritious beverage with protein and other nutrients.

12. COST ANALYSIS OF THE VCO PROJECT BY HOT PROCESS METHOD

12.1. Land and Building

The Virgin Coconut Oil making unit shall be located in the vicinity of the coconut growing area to ensure the continuous supply of raw material "coconut". As the plot area of about five cents is required for the project it can be purchased at the appropriate rate.

The investment on land @ Rs.1 lakh per Cent	:	Rs. 5,00,000
Built up area of 1000 sq.ft will be required for housing as well as facilities		
Hence investment on building @ Rs. 500/sq.ft	:	Rs. 5,00,000
Total investment on land & building	:	Rs. 10,00,000

12.2. Raw material

The raw material will be matured coconut. The coconut is dehusked and deshelled prior to be used as a raw material for VCO extraction. Five hundred coconuts yield about 100 kg kernel/gratings and 20 litres of VCO. The proposed processing unit will be having the capacity of processing 500 nuts daily which costs about Rs. 2000/- and for working 300 days in a year, the cost of the raw material comes to Rs. 6,00,000/-.

12.3. Miscellaneous expenses

Assets such as office furniture	:	Rs.	15,000
Pre operative expenses such as Registration, documentation, legal expenses, deposits such as for electricity, water etc., traveling and consultancy etc.,	:	Rs.	1,00,000
Administrative expenses like stationary and traveling	:	Rs.	10,000
Utility bills like electricity and water charges per year	:	Rs.	25,000
Total miscellaneous expenses	:	Rs.	1,50,000

12.4. Equipment and Machinery required for processing 500 coconut per day

Sl.No.	Name of the material	Specification	Quantity	Unit price (Rs.)	Total cost (Rs.)
1	Coconut dehusker	MS	5	250	1,250
2	Double sided coconut testa removing machine	Power operated	1	79,000	79,000
3	Coconut pulverizer	Power operated	1	1,35,000	1,35,000
4	VCO cooker	LPG fired or bio fuel fired	1	3,00,000	3,00,000
5	Coconut milk extractor	Hydraulic	2	75,000	1,50,000
6	Packing machine	100 ml to 250 ml bottles	1	42,000	42,000
7	Vacuum evaporator	–	1	1,45,000	1,45,000
8	Weighing Balance	Electronic	1	25,000	25,000
9	Miscellaneous items such as stainless steel containers, SS containers with trolley attached and other vessels, electrical fittings, electrical water heaters	–		75,000	75,000
				Total	**9,52,250**

12.5. Staff and Labour required

Sl.No.	Staff	No. of position	Salary / month (Rs.)	Salary / annum (Rs.)
1	Manager-cum-product supervisor	01	12,000	1,44,000
2	Unskilled labour	07	5,000	4,20,000
			Total	**5,64,000**

12.6. Working Capital

Sl.No.	Item	Quantity	Rate per unit	Amount
1.	Coconut	1,50,000	Rs.4 / coconut	6,00,000
2.	Packaging material	6,000	Rs. 5 / bottle	30,000
3.	Miscellaneous items	-	-	20,000
			Total	**6,50,000**

12.7. Capital investment

a.	Investment on land for 5 cents @ Rs.1 lakh per Cent	:	Rs.	5,00,000
b.	Investment on building for 100 sq.ft @ Rs. 500/sq.ft	:	Rs.	5,00,000
c.	Machinery and equipment	:	Rs.	9,52,250
d.	Miscellaneous assets	:	Rs.	1,50,000
	Total			**21,02,250**

12.8. Source of Finance

The fixed working capital is worked out to be Rs. 21,02,250. The amount shall be raised as given below.

a.	The entrepreneur (1/3rd)	:	Rs.	7,00,750
b.	Loan from bank (2/3rd)	:	Rs.	14,01,500
	Total		**Rs.**	**21,02,250**

12.9. Fixed cost

a.	Depreciation on plant, machinery and equipment @ 10 %	:	Rs.	95,225
b.	Depreciation on building @ 5%	:	Rs.	25,000
c.	Interest on term loan @ 12.5 %	:	Rs.	1,75,188
d.	Interest on working capital @ 11%	:	Rs.	71,500
e.	Repair and maintenance of machinery @ 5%	:	Rs.	47,613
f.	Salary	:	Rs.	5,64,000
g.	Administrative overheads	:	Rs.	10,000
h.	Insurance	:	Rs.	5,000
i.	Sales promotion and advertisement expenses	:	Rs.	10,000
	Total		**Rs.**	**10,03,526**

12.10. Variable cost

a.	Working capital including raw materials	:	Rs.	6,50,000
sb.	Other variable costs like electricity, watch and ward and other factory overheads	:	Rs.	50,000
	Total		**Rs.**	**7,00,000**

12.11. Profitability projections

Total cost of production (Fixed cost + variable cost)			**Rs. 17,03,526**
Cost of production	(17,03,526 / 6,000)	:	Rs. 284 per litre
Total cost of selling (6000 litres at Rs.350 / litre)		:	Rs. 21,00,000
	Profit	:	**Rs. 3,96,474**

Break even point = Fixed cost / [selling cost - (variable cost / No. of units)]
= 10,03,526 / [350 - (7,00,000 / 6000)]
= 10,03,526 / [350 -117]
= 10,03,526 / 233
= 4,307 litres of virgin coconut oil

Break even sales = 4,307 x 350
= Rs. 15,07,450

Break even period = 4, 307 / 20
= 216 days

12.12. Benefit cost analysis

Capital productivity analysis is the most important tool for evaluating the financial feasibility of any project. The *ex-ante* concept of cost benefit analysis is adopted to evaluate the present project. The study was confined to the direct costs and benefits, the social cost-benefit aspects are not accounted.

Discounted cash flow of virgin coconut oil production by hot process method

Year (n)	fixed cost (Rs)	variable cost (Rs)	Total cost	Total returns	Discounting factor	Discounted cost	Discounted benefits
0	1102250		1102250		1		-1102250
1	1003526	700000	1703526	2100000	0.889	1514245	1866667
2	1003526	700000	1703526	2100000	0.790	1345996	1659259
3	1003526	700000	1703526	2100000	0.702	1196441	1474897
4	1003526	700000	1703526	2100000	0.624	1063503	1311020
5	1003526	700000	1703526	2100000	0.555	945335.9	1165351
6	1003526	700000	1703526	2100000	0.493	840298.6	1035867
7	1003526	700000	1703526	2100000	0.438	746932.1	920771
8	1003526	700000	1703526	2100000	0.390	663939.6	818463.1
9	1003526	700000	1703526	2100000	0.346	590168.6	727522.8
10	1003526	700000	1703526	2100000	0.308	524594.3	646686.9
Benefit Cost Ratio (BCR)= 1.12							
Internal Rate of Return (IRR)= 34.05%							

Feasibility analysis of the project on commercial production of virgin coconut oil revealed a Benefit Cost Ratio of 1.12 and an Internal Rate of Return of 34.05 per cent. General theory as well as empirical studies on project feasibility analysis indicates that, a project with BCR value above 1 is always feasible. As far as IRR is concerned, it is advisable to compare the value with the prevailing returns we may obtain, had we invested the amount in other ventures. In the present study, the IRR is found to be 34.05 percent, which is well above that of any other prevailing market rate of return. Thus, we may conclude that the commercial production of Virgin Coconut Oil (VCO) by hot process method could turn out to be a highly profitable venture.

Since land is an appreciating asset, in the present capital productivity analysis the value of land has been excluded. Similarly, since we are accounting for the depreciation of building we are excluding that as well, instead we are imputing the leased/rental value of land and building. The rental value of land and building are imputed in terms of the annual interest rate we would have paid, had we purchased the land and building by taking a bank loan.

It is concluded that after producing 4,307 litres of virgin coconut oil, the no profit no loss point will occur which will correspond to a sales volume of Rs. 15,07,450 and this stage will arrive after 216 days of functioning of the unit.

Therefore the VCO making unit will start earning profit from eighth month after installation.

13. COST ANALYSIS OF THE VCO PROJECT BY FERMENTATION METHOD

The cost of land and building, raw material and miscellaneous expenses are same as mentioned in section 12.1, 12.2 and 12.3.

13.1. Equipment and Machinery required for processing 500 coconut per day

Sl.No.	Name of the material	Specification	Quantity	Unit price (Rs.)	Total cost (Rs.)
1	Coconut dehusker	MS	5	250	1,250
2	Double sided coconut testa removing machine	Power operated	1	79,000	79,000
3	Coconut pulverizer	Power operated	1	1,35,000	1,35,000
4	Fermentation tank	25 litres	5	1,000	5,000
5	Coconut milk extractor	Hydraulic	2	75,000	1,50,000
6	Packing machine	100 ml to 250 ml bottles	1	42,000	42,000
7	Vacuum evaporator	–	1	1,45,000	1,45,000
8	Weighing Balance	Electronic	1	25,000	25,000
9	Miscellaneous items such as stainless steel containers, SS containers with trolley attached and other vessels, electrical fittings, electrical water heaters	–	–	75,000	75,000
				Total	**6,57,250**

13.2. Staff and Labour required

Sl. No.	Staff	No. of position	Salary / month (Rs.)	Salary / annum (Rs.)
1	Manager-cum-product supervisor	01	12,000	1,44,000
2	Unskilled labour	07	5,000	4,20,000
			Total	**5,64,000**

13.3. Working Capital

S.No.	Item	Quantity	Rate per unit	Amount
1.	Coconut	1,50,000	Rs.4 / coconut	6,00,000
2.	Packaging material	6,000	Rs. 5 / bottle	30,000
3.	Miscellaneous items	-	-	20,000
	Total cost			**6,50,000**

13.4. Capital investment

a. Investment on land for 5 cents @ Rs.1 lakhs per Cent	:	Rs. 5,00,000
b. Investment on building for 100 sq.ft@ Rs. 500/sq.ft	:	Rs. 5,00,000
c. Machinery and equipment	:	Rs. 6,57,250
d. Miscellaneous assets	:	Rs. 1,50,000
Total		**18,07,250**

13.5. Source of Finance

The fixed working capital is worked out to be Rs. 18,07,250. The amount shall be raised as given below.

a. The entrepreneur (1/3rd)	:	Rs. 6,02,417
b. Loan from bank (2/3rd)	:	Rs. 12,04,833
Total		**Rs. 18,07,250**

13.6. Fixed cost

a. Depreciation on plant, machinery and equipment @ 10 %	:	Rs. 65,725
b. Depreciation on building @ 5%	:	Rs. 25,000
c. Interest on term loan @ 12.5 %	:	Rs. 1,50,604
d. Interest on working capital @ 11%	:	Rs. 71,500
e. Repair and maintenance of machinery @ 5%	:	Rs. 32,863
f. Salary	:	Rs. 5,64,000
g. Administrative overheads	:	Rs. 10,000
h. Insurance	:	Rs. 5,000
i. Sales promotion and advertisement expenses	:	Rs. 10,000
Total		**Rs. 9,34,692**

13.7. Variable cost

a. Working capital including raw materials	:	Rs. 6,50,000
c. Other variable costs like electricity, watch and ward and other factory overheads	:	Rs. 50,000
Total		Rs. 7,00,000

13.8. Profitability projections

Total cost of production (Fixed cost + variable cost)	:	**Rs. 16,34,692**
Cost of production (16,34,692 / 6,000)	:	Rs. 273 per litre
Total cost of selling (6000 litres at Rs.350 / litre)	:	Rs. 21,00,000
Profit	:	**Rs. 4,65,308**

Break even point = Fixed cost / [selling cost - (variable cost / No. of units)]

= 9,34,692 / [350 - (7,00,000 / 6000)]

= 9,34,692 / [350 -117]

= 9,34,692 / 233

= 4,012 litres of virgin coconut oil

Break even sales = 4,012 x 350

= Rs. 14,04,200

Break even period = 4,012 / 20

= 201 days

13.9. Benefit cost analysis

Capital productivity analysis is the most important tool for evaluating the financial feasibility of any project. The *ex-ante* concept of cost benefit analysis is adopted to evaluate the present project. The study was confined to the direct costs and benefits, the social cost-benefit aspects are not accounted.

Discounted cash flow of virgin coconut oil production by fermentation method

Year (n)	Fixed cost (Rs)	Variable cost (Rs)	Total cost	Total returns	Discounting factor	Discounted cost	Discounted returns
0	807250		807250		1		-807250
1	934692	700000	1634692	2100000	0.889	1453060	1866667
2	934692	700000	1634692	2100000	0.790	1291608	1659259
3	934692	700000	1634692	2100000	0.702	1148096	1474897
4	934692	700000	1634692	2100000	0.624	1020530	1311020
5	934692	700000	1634692	2100000	0.555	907137.9	1165351
6	934692	700000	1634692	2100000	0.493	806344.8	1035867
7	934692	700000	1634692	2100000	0.438	716751	920771
8	934692	700000	1634692	2100000	0.390	637112	818463.1
9	934692	700000	1634692	2100000	0.346	566321.7	727522.8
10	934692	700000	1634692	2100000	0.308	503397.1	646686.9
Benefit Cost Ratio (BCR)= 1.20							
Internal Rate of Return (IRR)= 57.01%							

Feasibility analysis of the project on commercial production of virgin coconut oil revealed a Benefit Cost Ratio of 1.20 and an Internal Rate of Return of 57.01 per cent. General theory as well as empirical studies on project feasibility analysis indicates that, a project with BCR value above 1 is always feasible. As far as IRR is concerned, it is advisable to compare the value with the prevailing returns we may obtain, had we invested the amount in other ventures. In the present study, the IRR is found to be 57.01 percent, which is well above that of any other prevailing market rate of return. Thus, we may conclude that the commercial production of Virgin Coconut Oil (VCO) by fermentation method could turn out to be a highly profitable venture.

Since land is an appreciating asset, in the present capital productivity analysis the value of land has been excluded. Similarly, since we are accounting for the depreciation of building we are excluding that as well, instead we are imputing the leased/rental value of land and building. The rental value of land and building are imputed in terms of the annual interest rate we would have paid, had we purchased the land and building by taking a bank loan.

It is concluded that after producing 4,012 litres of virgin coconut oil, the no profit no loss point will occur which will correspond to a sales volume of Rs. 14,04,200 and this stage will arrive after 201 days of functioning of the unit.

Therefore the VCO making unit will start earning profit from seventh month after installation.

14. COST ANALYSIS OF THE VCO PROJECT BY CENTRIFUGING METHOD

The cost of land and building, raw material and miscellaneous expenses are same as mentioned in section 12.1, 12.2 and 12.3.

14.1. Equipment and Machinery required for processing 500 coconut per day

Sl.No.	Name of the material	Specification	Quantity	Unit price (Rs.)	Total cost (Rs.)
1	Coconut dehusker	MS	5	250	1,250
2	Double sided coconut testa removing machine	Power operated	1	79,000	79,000
3	Coconut pulverizer	Power operated	1	1,35,000	1,35,000
4	Tubular bowl centrifuge	Power operated	1	6,50,000	6,50,000
5	Coconut milk extractor	Hydraulic	2	75,000	1,50,000
6	Packing machine	100 ml to 250 ml bottles	1	42,000	42,000
7	Vacuum evaporator	–	1	1,45,000	1,45,000
8	Weighing Balance	Electronic	1	25,000	25,000
9	Miscellaneous items such as stainless steel containers, SS containers with trolley attached and other vessels, electrical fittings, electrical water heaters-	–	–	75,000	75,000
				Total	**13,02,250**

14.2. Staff and Labour required

Sl.No.	Staff	No. of position	Salary / month (Rs.)	Salary / annum (Rs.)
1	Manager-cum-product supervisor	01	12,000	1,44,000
2	Unskilled labour	07	5,000	4,20,000
			Total	**5,64,000**

14.3. Working Capital

Sl.No.	Item	Quantity	Rate per unit	Amount
1.	Coconut	1,50,000	Rs.4 / coconut	6,00,000
2.	Packaging material	6,000	Rs. 5 / bottle	30,000
3.	Miscellaneous items	-	-	20,000
			Total cost	**6,50,000**

14.4. Capital investment

a. Investment on land for 5 cents @ Rs.1 lakhs per Cent	:	Rs. 5,00,000
b. Investment on building for 100 sq.ft@ Rs. 500/sq.ft	:	Rs. 5,00,000
c. Machinery and equipment	:	Rs.13,02,250
d. Miscellaneous assets	:	Rs. 1,50,000
Total		**24,52,250**

14.5. Source of Finance

The fixed working capital is worked out to be Rs. 24,52,250. The amount shall be raised as given below.

a. The entrepreneur (1/3rd)	:	Rs. 8,17,417
b. Loan from bank (2/3rd)	:	Rs. 16,34,833
Total		**Rs. 24,52,250**

14.6. Fixed cost

a. Depreciation on plant, machinery and equipment @ 10 %	:	Rs. 1,30,225
b. Depreciation on building @ 5%	:	Rs. 25,000
c. Interest on term loan @ 12.5 %	:	Rs. 2,04,354
d. Interest on working capital @ 11%	:	Rs. 71,500
e. Repair and maintenance of machinery @ 5%	:	Rs. 65,113
f. Salary	:	Rs. 5,64,000
g. Administrative overheads	:	Rs. 10,000
h. Insurance	:	Rs. 5,000
i. Sales promotion and advertisement expenses	:	Rs. 10,000
Total		**Rs. 10,85,192**

14.7. Variable cost

a. Working capital including raw materials	:	Rs. 6,50,000
b. Other variable costs like electricity, watch and ward and other factory overheads	:	Rs. 50,000
Total		**Rs. 7,00,000**

14.8. Profitability projections

Total cost of production (Fixed cost + variable cost) **Rs. 17,85,192**

Cost of production (17,85,192 / 6,000) : Rs. 298 per litre

Total cost of selling (6000 litres at Rs.350 / litre) : Rs. 21,00,000

Profit : **Rs. 3,14,808**

Break even point = Fixed cost / [selling cost - (variable cost / No. of units)]

= 10,85,192 / [350 - (7,00,000 / 6000)]

= 10,85,192 / [350 -117]

= 10,85,192 / 233

= 4,658 litres of virgin coconut oil

Break even sales = 4,658 x 350

= Rs. 16,30,300

Break even period = 4,658 / 20

= 233 days

14.9. Benefit cost analysis

Capital productivity analysis is the most important tool for evaluating the financial feasibility of any project. The *ex-ante* concept of cost benefit analysis is adopted to evaluate the present project. The study was confined to the direct costs and benefits, the social cost-benefit aspects are not accounted.

Discounted cash flow of virgin coconut oil production by centrifuge method

Year (n)	fixed cost (Rs)	variable cost (Rs)	Total cost	Total returns	Discounting factor	Discounted cost	Discounted returns
0	1452250		1452250		1		-1452250
1	1085192	700000	1785192	2100000	0.889	1586837	1866667
2	1085192	700000	1785192	2100000	0.790	1410522	1659259
3	1085192	700000	1785192	2100000	0.702	1253797	1474897
4	1085192	700000	1785192	2100000	0.624	1114487	1311020
5	1085192	700000	1785192	2100000	0.555	990654.7	1165351
6	1085192	700000	1785192	2100000	0.493	880582	1035867
7	1085192	700000	1785192	2100000	0.438	782739.5	920771
8	1085192	700000	1785192	2100000	0.390	695768.5	818463.1
9	1085192	700000	1785192	2100000	0.346	618460.9	727522.8
10	1085192	700000	1785192	2100000	0.308	549743	646686.9
Benefit Cost Ratio (BCR)= 1.03							
Internal Rate of Return (IRR)= 17.2%							

Feasibility analysis of the project on commercial production of virgin coconut oil revealed a Benefit Cost Ratio of 1.03 and an Internal Rate of Return of 17.2 per cent. General theory as well as empirical studies on project feasibility analysis indicates that, a project with BCR value above 1 is always feasible. As far as IRR is concerned, it is advisable to compare the value with the prevailing returns we may obtain, had we invested the amount in other ventures. In the present study, the IRR is found to be 17.2 percent, which is well above that of any other prevailing market rate of return. Thus, we may conclude that the commercial production of Virgin Coconut Oil (VCO) by centrifuge method could turn out to be a profitable venture.

Since land is an appreciating asset, in the present capital productivity analysis the value of land has been excluded. Similarly, since we are accounting for the depreciation of building we are excluding that as well, instead we are imputing the leased/rental value of land and building. The rental value of land and building are imputed in terms of the annual interest rate we would have paid, had we purchased the land and building by taking a bank loan.

In order to reach a 'no loss no profit' point in the production of virgin coconut oil, 4,658 litres of VCO is to be produced which corresponds to a sales volume of Rs. 16,30,300 and this stage can be arrived when the unit works for 233 days.

* * *