Assessing & Improving the Quality of Copra Oil to Edible Standard

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ACRONYMS

APCC	Asia Pacific Coconut Community
CEMA	Commodities Export Marking Authority
CIDP	Coconut Industry Development Program
Codex	Codex Alimentarius
FFA	Free Fatty Acid
GAP	Good Agricultural Practice
HACCP	Hazard Analysis Critical Control Points
KGA	Kastom Gadens Association
KPSI	Kokonut Pacific Solomon Islands
PHAMA	Pacific Horticulture and Agriculture Market Access
SPC	Secretariat of the Pacific Community
VCO	Virgin Coconut Oil

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The project was centred on the Chottu Estate in the Solomon Islands and the local contact Moses Pelomo of Kastom Gadens Association who toiled beyond obligation to ensure that arrangements were made and local collaborators were on board.

The wonderful people at Chottu Estate and especially the warm welcome, unflinching enthusiasm of the central character Jack Chottu is a joy for incoming consultants and advisers. The outcomes were enhanced by the senior members of the Commodities Export Marketing Authority who provide much needed back-up for the industry in Honiara.

A heartfelt thank you goes to all the workshop attendees. It was so encouraging to partake in the outburst of interest in the industry.

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EXECUTIVE SUMMARY

A review of the coconut industry (McGregor and Sheehy, 2018) has highlighted, among other issues, the balance of trade in edible oils for domestic use and the enormous strain it imposes on the Solomon Island economy. As a strategy to address this matter, this review represents the steps required to reach a point at which some imported oil can be replaced with locally produced coconut oil through a program of quality improvement. The program involved a review of the supply chain from coconut handling through the cutting, drying, pressing and filtering of extracted oil.

Of particular focus was the copra drying process which is commonly the source of discolouration in the oil and the stale or off flavours in the final product. A full review of the oil production at Chottu Estate was undertaken. Emphasis was placed on the physics of drying organic matter such as copra. Some simple low-cost modifications to the dryer and the process were discussed and included here. More efficient distribution of heat. Adequate removal of 'used,' (wet) drying air and more even distribution of copra drying sizes are all techniques that cost very little but can accelerated water removal even at lower temperature. Such strategies improve quality at an early stage in the chain.

A number of simple clean-up procedures with the ultimate aim of reaching standards for edible oil set by the Asia Pacific Coconut Community (APCC). Although the oil passing through acid-washed sand produced oil that conforms to APCC standard. The free fatty acid level was reduce from 0.4% in crude oil to 0.1% in the improved oil. The unsaponifiable matter was reduced from 1.1% in the crude oil to 0.3% in the improved oil. Both these values fall below the limits set by the Asia Pacific Coconut Community (APCC) for VCO. However this was a single experiment (duplicated) is not enough for true scientific assertion.

The pathway to further trials is suggested.

The production of oil is part of the process of producing safe wholesome food. The elements of food handling were given during a workshop in which a processing manual was supplied to attendees as an accompaniment to a slide presentation (available on request).

Production facilities for retail products were discussed with Chottu Estate staff and at present they are inadequate for edible food production. However, oil is not a high risk product and so with simple modifications the premises can be used for oil packaging and sale. Resources generated should be reinvested to upgrade the premises and a program incorporating priorities is given in this report.

A proposed, regular clean-down procedure for the premises is also given for when production begins.

Chottu Estate is only one of 12 such facilities in the Solomon Islands. Consideration should be given to a Code of Practice for use by all TinytechTM users. It should be prepared to complement the Hazard Analysis Critical Control Points (HACCP) Training Manual for Coconut Industry (SPC 2018).

RECOMMENDATIONS

It is recommended that:

- **copra is put through a coarse sieve so that sizes of copra can be more even preventing burning of smaller pieces before the larger pieces are dry.**
- **wherever there is a choice of location for the Tinytech™ mill it is placed in such a way that the prevailing wind will remove smoke.**
- **a system that encourages continuous removal for drying air is introduced into the drying floor.**
- **Copra should be allowed to cool after drying should be should be stored in containers that prevent re-sorption of water vapour from the air.**

The factors affecting oil quality are discussed but direct heat against the fire and the drying floor should be avoided. By the introduction of flat V-shaped baffles it should be possible to deflect the heating air along the drying floor more evenly and this is recommended.

The storage conditions for dry copra should be such that they prevent the access of vermin (rats, birds, flies) because the oil extracted will not be heated again and bacterial infection cannot be removed.

All equipment, including the drying floor should be cleaned regularly to ensure that ash and tars do not contaminate later batches.

Filtering is a very important step in removing physical hazards. All filtering materials should be kept in the best possible condition. Continuous washing and examination for defects should be routine and a written record kept between batches.

At this point the oil is usually in the best condition possible and should be stored in clean containers away from direct sunlight and the area around all storage areas should kept clear and items stored in such a way as to allow access for cleaning (Appendix 3A and 3B).

The following features for the establishment are of the highest priority and should be implemented prior to commencement of handling any edible item.

- **Access to the proposed training area should be limited to those engaged in food processing and who have received food handling training.**
- **Access by all animals and vermin (dogs, cats, birds, rats and insects) is prevented either by the use of curtains, shade cloth or permanent fixtures.**
- **There must be hand-washing facilties.**
- **There must be an adequate supply of hygienic (potable) water.**

It is suggested that advice to all mill operators is expanded possibly through the vehicle of a Code of Practice for the entire Solomon Islands. Common problems can be identified and low cost suggestions to overcome these problems included.
It is further recommended therefore that a full cost benefit is undertaken to ensure that adequate returns for additional effort can be realized.

It is recommended therefore that future work includes further investigation of the techniques used here (and in Rabi) to purify the oil. The work has to be systematic and results reproducible so that they can become institutionalized –possibly using the vehicle of a Code of Practice.

ASSESSING AND IMPROVING THE EFFICIENCY OF THE CHOTTU ESTATE COPRA MILL AND STRATEGIES FOR IMPROVING COCONUT OIL QUALITY

1 Introduction

1.1 Background

Coconuts are an extremely important crop among the Pacific island nations providing food, building material and fabric. A significant opportunity for the creation of employment and income for both urban and isolated communities is the extraction of oil both for fuel, cosmetics and ultimately for consumption.

Among Pacific island nations, the Solomon Islands figure as the most closely linked to coconuts with large plantations that have significant potential to offset import costs of edible oil, provide employment in rural areas and to expand significantly into cosmetic and industrial sectors.

The Solomon Islands imports over 7,000 tonnes of vegetable oil annually for a landed value of $SI 60 million (Solomon Islands National Statistics Office). This translates to *per capita* consumption of around 12kg per annum. There is apparently huge potential to substitute a part of this with locally produced oil. The obvious source of oil is copra as the climate is conducive to highly productive coconuts. Of the oil streams possible from coconuts, crude oil that has undergone simple extraction of cut dried copra, oil removal by pressing. However this oil is usually discoloured and strongly aromatic and has high levels of impurities emanating from the coconuts, the products of heating while drying, the pressing process and the packaging and transport. This oil is suitable for industrial processing including soap and cosmetic manufacture but not for consumption in its present state.

Virgin coconut oil (VCO) on the hand is prepared using a much milder process during which meat is gently turned while warming though. The meat is extracted using a manual mechanical press. VCO has undergone less damage that normal industrial processes and as such contains less impurities thereby offering alternative characteristics, in some cases nearing edible standard. However production is restricted to small scale only and the cost is too high for credible competition to imported cooking oils

The Chottu Coconut Products (CCP) CNO, is located in western Guadalcanal and has been selected for previous case studies (McGregor and Sheehy (2018). The company makes use of a Tinytech™ (small-scale technology Indian-made oil mill) for processing copra, which is supplied by a network of surrounding small-holder farmers. Tinytech™ mills of which there is a total of 12 have operated for over a decade. McGregor and Sheehy (2018) highlighted that they capital cost is low and running costs are competitive.

Most of the oil**,** is used for industrial, soap or cosmetic production during extraction. This undervalues the product and the value chain that has supported its production. Hence, an evaluation of the production processes is timely.

Coconut oil is being extensively promoted as a ‘healthy,’ oil, with benefits that include secondary protection to the heart and circulatory system. To assess the merits of this claim, the literature on the effect of coconut consumption on cardiovascular risk factors and outcomes in humans was reviewed. Eyers *et al* (2016) has reviewed 21 research papers of which 8 were clinical trials. Coconut oil generally raised total and low-density lipoprotein cholesterol to a greater extent than *cis* unsaturated plant oils, but to a lesser extent than butter. Observational evidence suggests that consumption of coconut flesh or squeezed coconut in the context of traditional dietary patterns does not lead to adverse cardiovascular outcomes.

However, due to large differences in dietary and lifestyle patterns, these findings cannot be applied to a typical Western diet. Overall, the weight of the evidence from intervention studies to date suggests that replacing coconut oil containing *cis* unsaturated fats would alter blood lipid profiles in a manner consistent with a reduction in risk factors for cardiovascular disease. Of note is the high concentration of lauric acid.

Table 1 Fatty Acid Composition of coconut oil

Common name	Composition	(%)
Caprylic acid	C 8:0	4 – 10
Capric acid	C 10:0	4 – 8
Lauric acid	C 12:0	45 – 56
Myristic acid	C 14:0	16 – 21
Palmitic acid	C 16:0	7.5 – 10.2
Stearic acid	C 18:0	2 – 4
Oleic acid	C 18:1	4.5 - 10
Linoleic acid	C 18:2	0.7 – 2.5

2 The Chain

2.1 Good Agricultural Practice

Many factors contribute to the quality of oil. International standards throughout the food industry define the hazards that may cause health risk and steps that can be taken to reduce that risk. The system Hazard Analysis and Critical Control (HACCP) is inclusive of all steps along the supply chain and include field production. The principles of Good Agricultural Practice (GAP) includes issues relating to farm practices. These include:

- Safe storage of pesticides and herbicides.
- Correct dosages and frequency of application of farm chemicals.
- Cleanliness of plantations free of rubbish and filth.
- Weed control, and,
- Correct storage of harvested nuts with early dispatch to the mills.

The biochemical changes that take place during maturing of nuts plays an important role in subsequent copra drying. Subjectively, the nuts are to be a complete grey with only slight swelling of the germinal node. The sugar content of coconuts varies enormously at maturity and this affects browning (caramellisation) during drying the products of which will persist through to the finished oil.

The optimal degree of maturity should defined – eg photographically - as far as possible and perhaps presages a Code of Practice for the entire process as time and funds permit.

2.2 The Process

Copra is extracted from the shell manually by halving the coconut and either slicing the flesh or removing half. Smaller pieces will dry faster.

Traditionally, extracted coconut flesh is dried using solid fuel dryer constructed from low cost materials.

The dryer is fuelled using husks and other readily available solid fuels. Ideally the facility should be sited in such a position that it takes advantage of the prevailing wind to remove smoke (Figure 1). Smokey flavours can taint the oil.

Figure 1 Weill sited copra mill. The smoke is removed efficiently by the prevailing wind

This study focused on the process where heat is applied during drying in TinytechTM devices. It will furthermore, offer details of some promising techniques for the improvement of coconut oil quality. In the event that coconut oil reaches those standards mandated by the Asia Pacific Coconut Community (APCC) then new markets with higher return may become available.

Wherever there is a choice of location for the TinytechTM mill it is recommended that it is placed in such a way that the prevailing wind will remove smoke.

In the Solomon Islands copra dryers are situated in areas where the rainfall and the average air humidity are high. Drying can only take place if the humidity of the air is lower than the moisture available (water activity) in the coconut flesh. Heating reduces the humidity of the drying air and this is achieved using solid fuel fires (see Section 2.3). Copra is spread on a metal surface which are directly heated.

Unfortunately this tends to 'cook,' the coconut leading to browning and generation of cooked flavours that persist into the finished oil. The chemistry of cooking process is well known (caramellisation, Maillard reactions and the Strecker degradation). These chemical changes occur most readily in foods with high sugar content, at high temperature and in items with low moisture content.

2.3 Drying Efficiency

Drying efficiency is highest if the relative humidity of the air used for drying is at its lowest possible level. Relative humidity is a measure of the water content of air. Air that has so much water vapour that it cannot take more is designated 'saturated,' and has a relative humidity of 100% - this is manifest when condensation or rain falls. Such air will deposit water on items with which it comes into contact. Unless it is raining most ambient air contains less than this saturated (100%) level. After a few sunny days with moderate breeze there is less water vapour in the air and it may drop as low as 50% of its water-holding capacity. This is the relative humidity of the air. Air with a relative humidity as low as this is rare in the Solomon Islands. For adequate drying the water holding capacity should at approximately 40% of total capacity or relative humidity 40%. Such air is suitable for drying.

In Honiara district, the air is rarely as dry as this, manifest by rainfall and standing water on the ground and the general pervading humidity. Hence the relative humidity of drying air must be reduced and this achieved by heating it. As air is heated it expands but the proportion of gases remains the same. Therefore, that same air will have a lower proportion of water vapour and thus heating reduces the relative humidity. Heating of ambient air will reduce its relative humidity and water will evaporate from the surface of the coconut pieces.

It is however, important to use air at a temperature that will not cause the cooking reactions to occur. The cooking and browning reactions will occur faster as products dry out. Hence carefully controlled dryers reduce the temperature as the product nears completion of drying.

Figure 2 Direct Heating of the Drying Floor

The efficiency of drying depends on:

- The difference between the available moisture of the food and relative humidity of the drying air.
- The surface area exposed to the drying air.
- The removal of the air that has picked up moisture from the copra since its relative humidity will have increased.

Whichever way the flesh is removed from the shell an even size distribution will enable even drying. If there is a wide range of copra sizes (Figure 3) then the smaller pieces will dry faster and are likely to burn while the larger pieces dry. Simple sieving of the cut copra through a coarse inclined screen will serve to equate copra size. The larger pieces can be introduced first and, as drying proceeds, the smaller pieces.

Figure 3 The wide range of copra sizes ready for drying means that the smaller pieces are prone to burning before the larger pieces are dry.

It is recommended that copra is put through a coarse sieve so that sizes of copra can be more even preventing burning before the larger pieces are dry.

Water only evaporates from the surface of the coconut pieces. Water within the pieces of copra has to migrate to the surface in order for it to evaporate. Hence, it is important to turn the copra so that each surface is exposed to the drying air. At the same time the drying air has absorbed water from the copra so that its relative humidity will increase and become useless for drying. Hence the drying air must be removed and replaced with newly heated drying air. Simple cowls attached to a mounted exhaust chimney will create draft to remove 'used, wet air.'

For the most efficient drying that causes the least damage to the copra, direct contact of the copra with very hot surface should be avoided. Copra contains varying amounts of sugar and high temperatures will accelerate the formation of caramel and products of charring (including the highly toxic benz-*a*-pyrenes).

The factors affecting oil quality are discussed but direct heat against the fire and the drying floor should be avoided. By the introduction of flat V-shaped baffles it should be possible to deflect the heating air along the drying floor more evenly and this is recommended.

As drying proceeds, the drying air will absorb moisture from the copra, it relative humidity will rise and moisture removal will be less efficient. It is therefore important the drying air is removed as drying proceeds to allow the introduction of fresh low relative humidity air.

It is recommend that a system that encourages continuous removal for drying air is introduced into the drying floor.

Figure 3. **Simple cowling mounted on the chimney will rotate even at low air velocity and remove hot moist air from the drying chamber.**

Air will only evaporate from a surface that is exposed to the drying air. Therefore, it is important to turn the copra during drying. The common practice is to rake over the copra. This is satisfactory provided that exposure of the drying surfaces is efficient.

The copra should be allowed to cool and it is recommended that, dry copra should be should be stored in containers that prevent re-sorption of water vapour from the air. Copra that is not kept dry will be difficult to mill.

The storage conditions for dry copra should be such that they prevent the access of vermin (rats, birds, flies) because the oil extracted will not be heated again and bacterial infection cannot be removed.

Milled, pressed copra is filtered through a filter press and the oil collected.

2.4 Contamination

As the quality of the quality of the oil approaches that required of vegetable oil, the principles of Hazard Analysis Critical Control Points (HACCP) should be introduced. A comprehensive training manual is available on line or from SPC (HACCP Training Manual for the Coconut Industry (SPC, 2018).

The procedure for HACCP is to identify hazards classified as:

- Biological (bacteria, yeasts, moulds, viruses and other vegetable matter.
- Chemical (insecticides, herbicides, petrol, oil and lubricants)
- Physical (wood splinters, shavings from worn equipment, nuts bolts and other hard objects)
- Environmental (contamination from a pollution source)’

The system examines the chances that these hazards reach edible material – RISK

Raw materials gathered from the field are always contaminated with a full spectrum of biological hazards from wind-blown dust, birds and insects. In addition, nuts that are not treated with care can accumulate soil and filth from all the materials making contact. Although much of the risk is eliminated as the husk is removed the copra should be handled with respect since ultimately there is opportunity for contamination if the copra is allowed to contact soil, unclean sacks etc.

At all stages of coconut handling, attempts should be made to prevent mould growth. Some species produce a toxin that among other things will cause cancer (aflatoxin). This is undesirable in both cosmetics and edible coconut products and its absence is now given priority among coconut oil importing countries.

Although coconut oil is not a high risk food item, some bacterial types will survive and damage the oil. What is more, it is morally incumbent on all food producers to produce food intended for consumption to produce safe wholesome food. Hence as soon as the copra is exposed all attempts should be made to eliminate all risks. Attention should be paid to ensure that risk of contamination from food handlers and the environment is kept to a minimum at all stages of the production chain.

All equipment, including the drying floor should be cleaned regularly to ensure that ash and tars do not contaminate later batches.

Although there is a large number of tests that can be performed to assess oil quality many relate to the origin of the oil and are used as a guide to adulteration. The most pertinent tests for assessing quality are the free fatty acid levels which indicate the degree to which the oil has undergone chemical degradation during processing – that is the fatty acids have been removed from the glycerol backbone, and the unsaponifiable matter which is an estimate of that which is not fat and is thus contamination.

Many oils are subject to deterioration during storage. The oxidation of the poly-unsaturated oils are most susceptible to oxidation and the resultant rancidity. Coconut oil is not so susceptible to oxidation – a process that is catalyzed by ultra violet light. Hence there it is not necessary to pack coconut oil in opaque containers. However, high temperature storage will result in degradation of the oil molecules leading to high free fatty acid levels some of which will impart a 'stale,' flavour in the oil.

3 Oil Clean Up

TinytechTM oils are commonly brown, and smell of coconuts and or smoke. Oil is judged on these physical attributes and removing the colour and flavour are required clean up procedures. Coincidentally clean-up processes also tend to reduce the free fatty acid content and the portion that is not oil – the unsaponifiable matter.

Large scale producers are also able to take advantage of economies of scale and the common clean-up procedures include steam distillation during which flavour compounds are removed by steam. This succeeded by passing the oil through an ion exchange column which removes particles and chemical components. These oils are then dried.

Small scale processing cannot support these expensive clean-up procedures. Hence care is required during the manufacturing process.

Filtering oil achieves much to remove particles but efficiency depends on mesh size. Washing oil is an important step since the products of oil damage during processing will accumulate at the interface between oil and water. The oil can be removed leaving the water layer and the debris with the water layer. This leaves the oil in a cloudy condition and the oil must be dried after washing to clarify it. It can be dried using mild heat or some desiccant such as alumina beads that are suitable for washing drying and re-use. This however, introduces an extra step in the process.

Low cost, locally available alternatives have been used. Charcoal which is easily prepared from low temperature combustion of coconut shells has a very large adsorptive if powdered. Finely powdered charcoal has previously been shown to remove the brown discolouration. Charcoal has been used on previous occasions (Beyer, 2018) and odour has been removed in VCO. However, charcoal produced at Chottu Estate proved unsuitable. An alternative to charcoal was sand. Sand was washed and dried and oil allowed to trickle down. Results for aroma removal were promising but not conclusive. As a modification, the sand was washed, dried and washed in acetic acid (vinegar). This was dried and then used for filtering the oil.

Many chemical tests have been developed to estimate the quality – particularly relevant at the moment because some common oils (soy, canola) are susceptible to the formation of 'trans,' fatty acids after prolonged heating. Such degradation products may have some link to cancer. Trans fatty acids will not form in coconut oil since the chemical make-up will not induce these reactions.

Tests were therefore limited to those appearing in the APCC standards and that give an indication of the degradation that the oil had undergone during extraction. The unsaponifiable matter value should be as low as possible (APCC standard is between 0.2 to 0.5%). The free fatty acid level should be as low as possible (APCC standard maximum 0.2%).

This is an arbitrary way of conducting but can be used as an indication of a simple procedure for removing the impurities. Comparative results were as follows:

	Colour	Appearance	Odour	Free Fatty Acid (APCC Standard)	Unsaponifiable matter (APCC Standard)
Extracted oil	Pale brown	Opaque	Coconut odour	0.4% (Max 0.2%)	1.1% (0.2 to 0.5%)
'Purified oil	Clear	Clear	Slight acetate aroma	0.1% (Max 0.2%)	0.3% (0.2 to 0.5%)

Using pre-washed, acid-activated the oil was odour-free and had reduced free fatty acids. Hence there has been a significant reduction in the unwanted matter in the oil bringing it closer to edible standard.

4. Food Handling

A workshop was undertaken to train participants in food handling. The oral presentation was supported by a power point presentation and a food manual (available on request). Although this is early in the evolution of the Chottu Estate edible oil project the importance of careful food handling has been stressed. The consuming public must have total confidence in food safety and wholesomeness. Although oil does not readily support bacterial activity the method of manufacture makes it prone to inclusion of both physical hazards such as machine fillings and extraneous matter such as wood shavings, husk particles and fine windborne trash. Continuous maintenance of mill machinery poses a threat of contamination of lubricants and other manufacturing chemicals.

Filtering is a very important step in removing physical hazards. All filtering materials should be kept in the best possible condition. Continuous washing and examination for defects should be routine and a written record kept between batches.

At this point the oil is usually in the best condition possible and should be stored in clean containers away from direct sunlight and the area around all storage areas should kept clear and items stored in such a way as to allow access for cleaning.

More difficult to detect are the chemical hazards that can contaminate oil. This relies on the general adoption of GAP and care at the handling stage to ensure that cleaning and lubricating items do not enter the oil.

All such techniques support the production of oil of the best possible quality.

Downstream activities should support this. In particular there mandatory practices as hygiene rules:

4.1 Food Handling Rules

For food handlers the following rules should be observed (from the training manual):

Rule 1 Food arriving at the processing area must be washed before it enters the processing area and any food that falls on the floor is contaminated and cannot be eaten without either washing carefully or reprocessing.

Rule 2 Any food, peelings or trimmings that fall on the floor must be removed immediately so that vermin (rats, mice, birds, insects, cats or dogs) will not be attracted to want the food production area.

Rule 3 Dirty areas such as around the vegetable or fruit washing area and the entrances should be washed regularly.

Rule 4 Waste food should be discarded at an area remote from the processing area so as not to attract vermin. (Wherever possible vegetable waste should be composted).

Rule 5 Movement in and out of the production area should be restricted to those staff who have undergone training in food hygiene and handling. Where possible all access doors should be self closing to prevent vermin from entering the food processing area. Access to people not involved in food processing should be prohibited.

Rule 6 All foods components including additives should be kept in sealable containers so that insects, birds, rats and mice will not be attracted to them.

Rule 7 Hands must be washed using soap and water after using the toilet – EVERY TIME.

Rule 8. Hands must be washed as you re-enter the food production area especially after smoking, using the toilet, eating or nose-blowing or sneezing into a handkerchief.

Rule 9 Smoking, chewing, eating and spitting are not permitted in the processing area. When taste testing foods, utensils used for tasting must not be returned to the food under preparation.

Rule 10 We never sneeze onto food and if we sneeze into a tissue it is thrown away immediately and if into a handkerchief we must wash our hands immediately.

Rule 11 Any symptoms of illness including colds, 'flu or boils or other skin lesions must be reported to the supervisor.

Rule 12 Staff incurring injuries that result in bleeding must be treated for emergency and removed from the processing area as quickly as possible consistent with safe First Aid practices.

4.2 Facility Requirements - New Premises

It is proposed that the current facilities will be converted for bottling and handling of the oil. As Figure 4 indicates considerable upgrade is required for food handling suitability. However oil is not a high risk product and there it is possible that bottling can be undertaken. Changes should be constant however as income permits but there must be an on-going program.

Figure 4 Proposed bottling are

4.3 Management of the premises

The following features for the establishment are of the highest priority and should be implemented prior to commencement of handling any edible item.

- **Access to the proposed training area should be limited to those engaged in food processing and who have received food handling training.**
- **Access by all animals and vermin (dogs, cats, birds, rats and insects) is prevented either by the use of curtains, shade cloth or permanent fixtures.**
- **There must be hand-washing facilties.**
- **There must be an adequate supply of hygienic (potable) water.**

As funds permit the following items are priority.

There must be two self-closing doors between the toilet and the food handling area.
Where new premises are proposed, facilities should be located, designed and constructed to ensure that:

- Conditions should be satisfied where necessary to protect the safety and suitability of food: the surfaces of walls, partitions and floors should be made of impervious materials with no toxic effect in intended use;
- Walls and partitions should have a smooth surface up to a height appropriate to the operation;
- Junctions at walls and floors should be coved with inert material with a diameter of 0.6 cm.
- Floors should be constructed to allow adequate drainage and cleaning and there should be no pooling of water;
- Ceilings and overhead fixtures should be constructed and finished to minimize the buildup of dirt and condensation, and the shedding of particles and all electrical fittings to be water-proof so that the entire premises can be hosed;
- Windows should be easy to clean, be constructed to minimize the buildup of dirt and where necessary, be fitted with removable and cleanable insect-proof screens. Where necessary, windows should be fixed;
- Doors should have smooth, non-absorbent surfaces, and be easy to clean and, where necessary, disinfect;
- Working surfaces that come into direct contact with food should be in sound condition, durable and easy to clean, maintain and disinfect. They should be made of smooth, non-absorbent materials, and inert to the food, to detergents and disinfectants under normal operating conditions.
- Design and layout permit appropriate maintenance, cleaning and disinfections and minimize air-borne contamination;
- Surfaces and materials, in particular those in contact with food, are non-toxic in intended use and, where necessary, suitably durable, and easy to maintain and clean;
- There is effective protection against dust, fumes and smoke.

4.4 Clean-down Procedures

Once production is underway then hygiene must be maintained by regular clean-down procedures. To ensure that clean-down is undertaken efficiently and comprehensively, checklists should be used. These ensure that the correct cleaning materials are used in the correct dilution, and that all important surfaces are included.

There is a range of cleaning material designed for removal of all classifications of contaminants (fat, soil, grease etc). In the early stages it is important to remove oil from surfaces after production and simple household cleansing agents.

Household bleach diluted 1 in 10 is a powerful bactericide. It should not contact food but is useful for rinsing utensils and surfaces before use. Used as the production run is coming to an end the active component will evaporate overnight and will not taint the food.

As the program progresses more sophisticated cleaning materials can be incorporated as funds permit. Clean-down should not however be neglected.

5 Results

The crucial issue regarding the quality of oil from the TinytechTM equipment is the efficiency of drying. The current design and use of the directly heated drying floor risks overheating of copra and the resultant browning and charring of the copra. The products of the chemical reactions that take place carry over to the final oil.

Brown discolouration is used as a measure to oil quality and this restricts the end use for cosmetics and soap.

Some browning reactions are related to the sugar content of the coconuts. After harvest, storage and germination, the sugar content varies extensively. It is important to standardize the maturity as far as possible.

For efficient drying:

1. Water is only removed from the copra if the relative humidity is less than the available moisture in the copra.
2. Heat from the solid fuel fire chamber should be distributed along the drying floor by the incorporation of baffles to distribute the heat more evenly.
3. Copra is cut in different sizes, larger pieces will dry slowly but smaller pieces will dry more quickly and run the risk of burning. The smaller pieces should be sieved and added at a later stage of drying.
4. The siting of the mill should be such that the prevailing wind will remove smoke from the drying area.
5. Air that has removed moisture from the copra becomes humid and therefore cannot remove moisture from the copra, it therefore should be removed. A simple fan or a cowl attached to the exhaust chimney will draw hot air from the drying floor.
6. Moisture only evaporates from the exposed surface to the copra should be raked to expose ‘wet,’ surfaces.
7. On completion of the drying process, the copra should be cooled and stored in water-proof containers in a site that this vermin-proof.

There are promising ways in which the oil can be cleaned. By careful filtering and passing the oil through an adsorbent pre-washed with acid not only removes brown colouration and the coconut odour.

One simple test relating to the free fatty acid indicates that significant progress has been made towards the production of edible oil. However it is unlikely that the oil will be used for repeat frying. However, this does not preclude use in single use products such salad dressings, glazes and mayonnaise.

6 Future Work

The review of the procedure was confined to that undertaken at Chottu Estate. This is operation is one of 12 Tinytech™ machines in the Solomon Islands. Momentum for the industry and opportunities to collaborate over more sophisticated oil purification exist if other Tinytech™ operations are included.

It is suggested that advice to all mill operators is expanded possibly through the vehicle of a Code of Practice for the entire Solomon Islands. Common problems can be identified and low cost suggestions to overcome these problems included.

Sustainability and continued success in food processing operations are founded in a reasonable return for effort. The work towards the production of edible oil but the effort that must be invested in improving oils must result in products that can command higher prices to compensate.

The projected volumes of oil from the combined output of all the Tinytech operations is unlikely to match the economies of scale and sophisticated purification processes of those of imported cooking oils. The market is likely to be high value single-use products such as mayonnaise, salad oil – products that require further value-adding.

It is further recommended therefore that a full cost benefit is undertaken to ensure that adequate returns for additional effort can be realized.

The purification process that has been undertaken here demonstrates that low cost purification processes can improve oil quality. However the trials undertaken need further investigation to ensure that the procedure is reproducible.

It is recommended therefore that future work includes further investigation of the techniques used here (and in Rabi) to purify the oil. The work has to be systematic and results reproducible so that they can become institutionalized –possibly using the vehicle of a Code of Practice.

APPENDIX 1
Contacts made

Review of Chottu Coconut Mill

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APPENDIX 2

Essential Composition and Quality Factors of Virgin Coconut Oil

Parameter	Specification
Moisture (%)	Max 0.1
Volatile Matters at 120^{0}C (%)	Max 0.2
Free Fatty Acid (%)	Max 0.2
Peroxide Value meq/kg	Max 3
Relative density	0.915 – 0.920
Refractive index at 40^{0}C	1.4480 – 1.4492
Insoluble impurities per cent by mass	Max 0.05
Saponification Value (Mg KOH/g oil)	250 – 260 min
Iodine Value (Wijs)	4.1 -11
Unsaponifiable matter % by mass, max	0.2 - 0.5
Specific gravity at 30 deg./30^{0}C	0.915 – 0.920
Polenske Value, min	13
Total Plate Count	< 0.5
Color	Water Clear
Odor and Taste	Natural fresh coconut scent, free of sediment, free from rancid odor and taste

APPENDIX 3 A

Daily Clean-down Procedures Small Scale Processors

	Checked by	SANITISER/CLEANING AGENT Chlorine	DILUTION	RESIDENCE TIME	Repairs and upgrades required
Floors					
Walls and Windows					
Ceilings					
Doors					
Bench tops					
Sinks					
Drains and draining channels					
Pipes					
Storage bins					
Cleaning brushes and cloths					
Cleaning cloths and brushes					

Dry waste disposal					
Exposed beams and pipes					
Wiping cloths					

APPENDIX 3 B

Weekly Clean-down Procedure Small Scale Processing

	RESPONSIBILITY	SANITISER/CLEANING AGENT Chlorine	DILUTION	RESIDENCE TIME	Refurbishment required
Ceiling					
Exposed pipes and beams					
Walls and windows					
Packing room					
Shelves and benches					
Floor					
Approaches					

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