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VIRGIN COCONUT OIL:

State of the Art

Editor:
Bienvenido O. Juliano, PhD
National Scientist

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Virgin Coconut Oil: State of the Art

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National Academy of Science and Technology, Philippines
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(May 31, 1919–October 6, 2007)
Cardiologist and Pharmacologist

Republic of the Philippines
Department of Agriculture
PHILIPPINE COCONUT AUTHORITY
Diliman, Quezon City

In behalf of all the stakeholders of the coconut industry
this

PLAQUE OF RECOGNITION

is given to

DR. CONRADO S. DAYRIT
MD, FPCP, FPCC, E-FACC

for his invaluable contribution in bringing to modern day living the scientific and pharmacological basis of the ancient wisdom and practice of using coconut oil in enhancing human health and vigor.

A distinguished academician and practitioner in the fields of pharmacology and cardiology, he stood by our coconut when the world was swayed against it.

Holding his faith and conviction, he conducted vital researches and studies for forty-five years with dedication to herald the truth that coconut is the healthiest oil for human health.

The coconut industry, all its stakeholders, and the Filipino nation owe him very much for being one of the great minds which has rekindled and developed interest in and awareness on coconut and its health benefits.

He restored the lost glory of the coconut and placed it back to the pedestal where it really belongs: the best oil in the world.

Given this 7th day of February, 2007 at the Traders Hotel Manila, Roxas Boulevard , Pasay City

OSCAR G. GARIN
Administrator

Welcome Remarks

Acd. Emil Q Javier, PhD

President
National Academy of Science and Technology

Coconut, the tree of life, is of great value and interest to our country. Coconut products constitute our largest food exports and the crop occupies 3 million ha, providing sustenance to about the same number of farm families.

There is growing interest locally and abroad in virgin coconut oil as a functional health food and for other wellness and personal care applications. In order to optimize the benefits from VCO and provide for its sustainability in the long term as an industry, it is timely and appropriate that the different stakeholders come together to map the industry's future.

This symposium on Virgin Coconut Oil: State of the Art aims to serve as venue to review the current state of VCO production, standards and health effects and to set priorities for future direction in VCO production, standards and health research in the country.

Allow me to congratulate all the members of the National Committee, headed by National Scientist Bienvenido O. Juliano, our co-sponsors and stakeholders for the time and expertise they have shared to make this event possible. Your active participation in the deliberations and in preparing the recommendations will be valuable inputs in setting the standards and priorities on issues concerning VCO in the country.

Welcome and ***mabuhay po tayong lahat***!

Overview and Rationale

NS Bienvenido O. Juliano, PhD

Chair
NAST National Committee on Coconut Oil Research for Health

Coconut oil has been controversial for the last few decades. It has been termed both as a bad oil and as a good oil. Refined bleached and deodorized coconut oil (RBD CNO) from copra is mainly used as a cooking oil. It is the most saturated of oils and rich in medium-chain (8-12 carbon) fatty acids. Coconut oil has been erroneously grouped with the long-chain (14 or more carbon) saturated fats that are claimed to cause heart diseases, based on the controversial 1970 Lipid-Heart Theory: that saturated fats increase blood cholesterol, which in turn contribute to heart disease. Coconut oil exports to the US for food use was then severely reduced and replaced by US native and partially hydrogenated corn and soybean oils. Studies favorable to coconut oil were suppressed from publication to the benefit of unsaturated US corn and soybean oil industries. The health benefits of medium-chain fats, such as coconut oil, as reported in the 1950-1980 studies by unbiased Western scientists had to be hidden behind names like medium chain triglycerides (MCT) to be published. MCT derived from coconut oil were accepted as good for infants, elderly, convalescent and athletes. Despite these publications and various fora extolling the merits of coconut oil, many local physicians, nutritionists and consumers continue to consider coconut oil as a bad oil. Coconut oil producers label their product as vegetable oil, with coconut oil in fine print. Similar suppression of the high content of *trans* fatty acids in partially hydrogenated unsaturated oils was undertaken to protect the US vegetable oil industry. But the toxic effect of *trans* fatty acids contributory to heart disease is now accepted to be worse than that of saturated fats. The US Food and Drug Administration now requires the inclusion of content of saturated and *trans* fatty acids in the food label.

Virgin coconut oil (VCO) extracted from fresh mature coconut is a Philippine phenomenon of the 21st century. It is a food supplement taken orally by the spoonful or by capsule or applied externally for various ailments. Testimonials by satisfied users have increased the demand for virgin coconut oil. Because of the absence of product standard and replicated clinical studies and unconfirmed reports of product rejection by importing countries,

there was concern that VCO may go the fate of *nata de coco*. Cognizant of the situation, NAST held a Round-Table Discussion on coconut oil on June 8, 2004 followed up by an organizational meeting on June 21, 2004 to establish the National Committee on Coconut Oil Research for Health to identify through its subcommittees the priority short-term research studies on virgin coconut oil and to assist in having them funded. NAST has no research funds being mainly a recognition and advisory body. Subcommittees of the National Committee are: Basic Research, Standards, Clinical Research, Nutritional Research, Epidemiological/Public Health Research, Agribusiness, and Advocacy. Each subcommittee deliberated on their research agenda. The use of RBD coconut oil as check was encouraged. I was recruited by NAST President Dra Perla Santos-Ocampo to chair this committee during the annual meeting of NAST in July 2004.

This committee assisted Philippine Coconut Authority and Bureau of Agriculture and Fisheries Product Standards in the drafting of the Philippine National Standard for virgin coconut oil as food which was approved in late 2004: no differentiation among VCO products was made and the difference to RBD coconut oil was based only in color and scent. The Department of Agriculture created in 2006 a Technical Working Group for the revision of the Philippine National Standard (PNS) for VCO composed of representatives from PCA, BFAD, BAFPS, AdMU, BIOTECH UPLB, NAST, DOST and VCO Philippines. The PNS for flavored VCO was recently approved. Revisions on the PNS for VCO have been recommended last week but studies so far have not differentiated VCO from RBD CNO.

DOST earmarked through PCHRD PhP3M for health studies approved by the Clinical Research Subcommittee. Priority was given to *in vitro* and short-term studies. The Committee drafted a position paper on the benefits of coconut oil in 2005 as rebuttal to the letter of some US Senators to the US FDA on coconut oil and for advocacy purposes. The position paper is included as an appendix to the NAST publication "Coconut Oil: Issues and Prospects". UP Manila National Institutes of Health commissioned a literature review on public health and epidemiological research needs and issues regarding coconut oil and cardiovascular diseases 2005 completed in 2006 by the Epidemiological/Public Health Subcommittee and awaiting publication. The Committee recently prepared through the Subcommittee on Clinical Research, a wish list of priority research topics on standards, health research and advocacy with budget estimate, including long-term studies for the reference of possible donors. Interested participants are encouraged to comment on this list. The Advocacy Subcommittee is preparing a campaign on the merits of coconut oil as a good oil.

In October 2006, DOST unveiled its interagency Science and Technology Program for Virgin Coconut Oil to generate scientific facts in safeguarding the quality and substantiating the health claims of VCO and

sustaining industry growth. Activities of the program aim to differentiate VCO from RBD CNO, conduct a comparative evaluation, scientifically determine the health benefits, determine agronomic factors, and provide technical support mechanisms. PhP37M has been budgeted for this program.

The NAST Coconut Committee unanimously recommended in 2006 the holding of a state of the art symposium on VCO in early 2007. Although some excellent meetings and fora had been recently held on the health aspects of VCO, a wholistic review of the current status of VCO production, standards and health effects was needed as a basis for setting priorities for future directions in production, standards and health research to sustain the Philippine VCO industry, taking into consideration the limited research funds and other resources in the country. We should keep in mind this second objective during today's symposium. The results of this symposium will inform the stakeholders on the urgent action needed to sustain the growth and protect the VCO industry. Sister agencies in the DOST, PCA and VCO Philippines join us in this undertaking. We thank the speakers for accepting their assignments and NAST-Philippine Science Heritage Foundation, Inc. for the physical arrangements of this symposium.

Message

Prof. Fortunato T. Dela Peña

Undersecretary, Department of Science and Technology and President, National Research Council of the Philippines

As we open this symposium this morning I cannot help but be reminded, of course, of the decades-long campaign by anti-coconut oil advocates who made all of us believe that coconut oil is bad for one's health. Up until a certified nutritionist, I think the name is Dr. Bruce Fife, opened our eyes including nutritionists and skeptical medical practitioners to the fact that coconut oil's unique and abundant anti-microbial properties make it superior to any other oil. I think Dr. Fife then said that he was intrigued when he learned that coconut oil is being used in hospital formula to feed critically ill patients and is a major component of baby formulas. So the more he researched on this much-maligned coconut oil, the more he unearthed a wealth of health-saving information.

In the local scene, I guess about 2 to 3 years ago, just as the efficacy of virgin coconut oil (VCO) was being pushed, our very own Dr. Conrado Dayrit, started testing the dietary oil on HIV-positive patients and this bold initiative drew the nation's interest and woke up a sleeping industry on the healing potential of VCO. Henceforth, VCO became one of the more lucrative dollar earners. And in the first quarter of 2006 alone, the Philippine Coconut Authority reported that the country's export earning from coconut products stood at US$447M, characterizing the performance as principally buoyed up by the greater volume of coconut oil exported.

So amidst the dangers posed by high cholesterol intakes to one's health, including the deadly emergent diseases, Filipinos now opt to return coconut oil to their tables. This is, I guess, not just a hype but a necessity to produce more. Not just with great volumes appropriate to the great demand but that of great efficacy for targeted illnesses.

I would like to share with you my sometimes embarrassing experience whenever I go to Congress to face the Committee on Science and Technology. The Chair, Congressman Antonio Diaz of Zambales, somehow, after being briefed by a scientist on VCO and after having been informed that the revised standards are still being awaited, told me in one meeting to see to it that such revised standards should come out even if we already told him that there is a

technical working group. Wherever he sees me, he points to me and asks me "Where are these standards?" And you know, it can be very embarrassing. So for my own sake and for the sake of DOST's budget, I hope that the revised standards will come out.

So I would like to wish all the participants today, more particularly our producers, can we have a show of hands who are the producers here? *Aaah, marami rin, ano*? To our producers, I would like to repeat an often-repeated phrase, "You produce the right oil, we provide you with the science."

So I hope that we will have a very productive undertaking today and good morning once again to everyone.

Message

Acd. Conrado S. Dayrit, MD, FPCP, FPCC, E-FACC

President
NAST- Philippine Science Heritage Foundation, Inc.

This symposium on the State of the Art of Virgin Coconut Oil (VCO) is timely; it addresses the two most pressing problems – VCO standards and proofs of efficacy.

Three years ago, coconut oil (CNO) extracted from copra and subjected to refining processes (Refining-Bleaching-Deodorizing) was just for cooking. It had no medical uses. And being the most saturated of all fats and oils, coconut oil was condemned as causing heart disease and hence was a "no-no". [Yet, MCTs (medium chain triglycerides – CNO's very own) were regarded as very good even for infants, the elderly, convalescents and athletes.] The tremendous health benefits of the medium chain fats, as reported by the 1950-1980 studies of a host of unbiased scientists (Kaunitz, Bach, Babayan, Kabara, Thormar, Enig, et al) were not allowed to surface and were kept hidden behind names like MCT or medium chain monoglycerides. By avoiding the bad name of "coconut oil", these studies were admitted for publication, while those using the name "coconut oil", particularly if beneficial, were not. Hence, very few, if any suspected that these strange names were aliases for the undesirable coconut oil? There, also, were reports that all the peoples that eat coconuts and use its oil daily for their food and nutrition had little or no heart disease and had low cholesterol; these were simply ignored as of little value with the assertion that randomized controlled trials (RCTs) were for necessary proof. Imagine relegating epidemiological studies to "no value"?!!! All the while, the flawed Ancel Keys and MRFIT studies (with their biases and statistical manipulations) were unquestionably accepted as proofs of the Cholesterol/ Lipid-Heart Theory – now severely under question and under revision, although still blindly followed by doctors and laymen.

Year 2004 was when VCO appeared in the market. For the first time, coconut oil, as VCO, is being taken orally by spoonsful and, more than ever, applied externally, for various ailments, systemic and dermatologic – against many doctors' knowledge or advice. Having tried Western drugs

and medicines and not finding the cure or satisfactory control they desire, when they find these with VCO, they tell friends and relatives how good is VCO. This is the explosion of 2004-2005 that continues to this day. But these anecdotal reports are of little value, say the MD-scientist-specialists. Not I say when there are so many of them and some as detailed as our admissible Case Reports. Since the beginning of time, medical science had progressed in this way – by anecdotal observations. Many truths in medicine had been proven by a few well-controlled solitary experimentations. But we need to verify these independent reports by more acceptable forms of evidence – RCTs.

VCO is now being sold nationally and abroad. The quality of these products must be controlled as strictly as with other nutraceuticals and pharmaceuticals. Since our available funds for research are meager, the setting of priorities for researches to be undertaken need wise planning. This is our task and this is why this meeting is so important.

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State of the Art: Virgin Coconut Oil Production in the Philippines

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Abstract

The health and nutritional attributes of virgin coconut oil (VCO) made it popular in domestic and global vegetable oil market. Currently, the country has its competitive advantage in terms of production and quality of the product. Increasing number of producers are into this microenterprise business thus competing with the supply of raw materials to other traditional coconut products. Due to the emerging opportunities from VCO, four major processing technologies were developed by government institutions and private sectors that are most commonly used by commercial VCO producers. These are classified as the wet methods (fermentation, centrifuge and the enzymatic process) and the dry methods (fresh-dry process: desiccated coconut route, fresh-dry process: grated coconut route and the fresh-dry: wet milling route). Further modifications were also done by other producers to improve the quality and oil yield from the different technologies being adopted. These processing technologies can be differentiated in terms of production capacity and production cost. Moreover, the quality of VCO and yield differ for every process and has its own respective advantages and limitations. This results in a wide range of pricing of VCO products and by-products in the market. At present, with the opportunities and constraints of the VCO industry, the foremost concern is to comply with the increasing demand and regulate the production of quality products to maintain the present position of VCO as the highest-priced oil in the world market.

Introduction

The virgin coconut oil (VCO) is considered a non-traditional but highly priced commodity among the hundreds of product lines of coconut. It is an income-boosting enterprise and is currently gaining popularity both in local and international markets. It is very much sought after and has established a niche market of its own as a functional food for human consumption because of its various health benefit claims. Since it is extracted from fresh and mature nuts and not from dried coconut meat (copra) it has astounding health and nutritional benefits. Based on the records, the trend of world demand for VCO is rapidly increasing and production in the country is similarly coping up with this new expansion in the export arena. Moreover, increasing local consumption was also recorded based on local production and sales volumes reported by VCO producers to PCA. This industry was also proven profitable and promising as a low investment microenterprise with high market demand. Thus, with VCO becoming a promising export commodity, more and more VCO producers and traders have emerged like mushrooms everywhere in the country. This income-generating enterprise can improve farm incomes by 5-8 fold over the traditional copra production or sale of fresh nuts (Bawalan and Chapman, 2006).

VCO production process is basically very different compared to the way commercial coconut oil (CNO) is processed. The latter is extracted from copra or the dried coconut meat and is then refined, bleached and deodorized (RBD). Such coconut oil is usually used for cooking purposes. In the case of VCO the oil is extracted purely from fresh meat without any harsh heat or chemical treatment (hence the name "virgin"). With the popularity of the VCO, improvements in processing, product development and utilization in the production of high-end products were made possible within a short duration. Innovations in labeling and packaging for the discerning consumers were offered by most producers. VCO is now available not only in bottles, but also in jars, soft gel capsules and as flavored VCO in different tastes. Many high-end products like massage oils, lotions, balms, creams and soaps made with VCO base are also available.

Production Status

The Philippines is keeping its lead in VCO production over Indonesia which could be a competitor in the world market. However, considering that our country is ahead of them in this technology, we have a competitive edge with foreign investors interested to venture in this industry. At present, a production capacity of 2,931 mt was reported to PCA (2005) and according to Absolutely No Heat Coconut Oil Producers, Inc. (ACOPI), their members have the capacity to produce 50,000 L of VCO with the cold process technology (PCA, 2006).

With the increasing number of producers venturing in this business, the industry might be facing competition with the traditional products for

stable supply of suitable nuts. The country is still considered as number one exporter of traditional coconut oil and other coconut products. It is also considered second in the world in terms of areas planted to coconut (3.1M hectares). And despite this, a shortage in supply of nuts is an expected problem in the industry. With the increasing demand for VCO, the need for more raw materials will eventually result in abrupt reduction of nut supply to oil millers and desiccated coconut (DC) plants. Furthermore, it was also noted that most of the new VCO plants have emerged in locations where oil mills and DC plants are already located. Based on records of the registered VCO plants (PCA, 2006) about 27.52% were established in Region VIII (Eastern Visayas), 18.9% in Southern Luzon (Region VI-A) and followed by Bicol (Region V) with 10.9% VCO producers (Table 1). There are only 40 VCO producers who are registered with BFAD mostly based in National Capital Region and Southern Luzon.

Table 1. List of VCO producers and exporters in the Philippines and the coconut production in 14 coconut growing regions, 2007.

Region	Location	Nut production (in mt)	No. of VCO producers/exporters	% Share
National Capital Region (NCR)	Luzon	NR	11	5.04
Region IV– B Central Luzon and MMROPA	Luzon	933,832	12	5.50
Region IV– A Southern Luzon	Luzon	1,483,600	41	18.79
Region V – Bicol	Luzon	1,185,327	22	10.09
Region VI – Western Visayas	Visayas	500,013	16	7.33
Region VII – Central Visayas	Visayas	354,190	18	8.25
Region VIII – Eastern Visayas	Visayas	1,764,645	60	27.52
Region IX – Zamboanga Peninsula	Mindanao	1,637,823	02	0.93
Region X – Northern Mindanao	Mindanao	1,548,758	13	5.96
Region XI – Central Mindanao	Mindanao	2,493,554	10	4.59
Region XII – SOCCKSARGEN	Mindanao	779,317	04	1.83
Region XIII – CARAGA	Mindanao	973,115	07	3.22
Region XIV – ARMM	Mindanao	1,170,409	02	0.93
TOTAL		**14,824,585**	**218**	**100**

VCO Processing Technologies

Studies have shown that the quantity and quality of oil vary depending on the age of nut, variety, geographical location, part of the fruit and method of oil extract ion (Padolina et al, 1987). Results of biochemical studies revealed differences in fatty acid composition of the oil with reference to varieties (Laureles et al, 2002). Lauric acid (C12) content was significantly higher in the hybrids PCA 15-8 (50.45%), the cross between Tacunan dwarf and Bago-Oshiro tall and PCA 15-9 (Tacunan x Tagnanan) with 50.26% C12 content which is about 3.16% points compared to seven other hybrids, and higher in Tacunan Green Dwarf (50.50%) among the eight parent materials.

While the fatty acid composition can be a basis to differentiate the cultivars, it appears that it cannot be used to differentiate the various processing methods of VCO production. This was shown in the recent study undertaken by Prof. Fabian Dayrit, College of Chemistry, Ateneo University. However, differences were observed in VCO and refined, bleached deodorized coconut oil (RBD-CNO) when analyzed for volatile components using solid phase micro extraction gas chromatography (SPME-GC), monoglycerides and phytosterols by gas chromatography-mass spectroscopy (GC-MS) and diglycerides by pulse nuclear magnetic resonance (PNMR). Further studies are still on-going on these aspects.

It can be deduced that the choice of the technology to produce the VCO will depend on the scale of production, the available capital and the required quality of the product in the target market. The scale of operation will be based on the coconut supply in the prospective area to establish the VCO plant.

The Philippine National Standards (PNS) for VCO specifies various quality standards in terms of physical, chemical, microbiological requirements, essential composition of VCO, labeling, methods of analysis and sampling. However, they do not identify or specify the acceptable processes. Various VCO processing technologies were generated in the country that can be differentiated in terms of production capacity and production cost which can meet the quality requirements. Moreover, it was also reported that VCO produced by each process differs in organoleptic characteristics identified by sensory evaluation (Bawalan and Chapman, 2006). These are classified into two major types: (1) dry process and (2) wet process.

The dry processing method has several variations as follows: fresh-dry process; desiccated coconut route; fresh-dry process, grated coconut route; and fresh-dry, wet milling route.

On the other hand, the wet process varies in terms of fermentation and centrifugation, enzyme treatment and a combination of the dry and wet process (Bawalan and Masa method).

Dry process

Fresh-Dry Process, Desiccated Coconut Route involves de-shelling of the meat by a de-shelling machine, paring, washing, grinding, blanching and drying (Fig. 1). The dried ground meat is passed through an expeller to extract the oil. As a by-product food grade, high protein, medium fat coconut flakes is also produced. This is further ground to produce coconut flour.

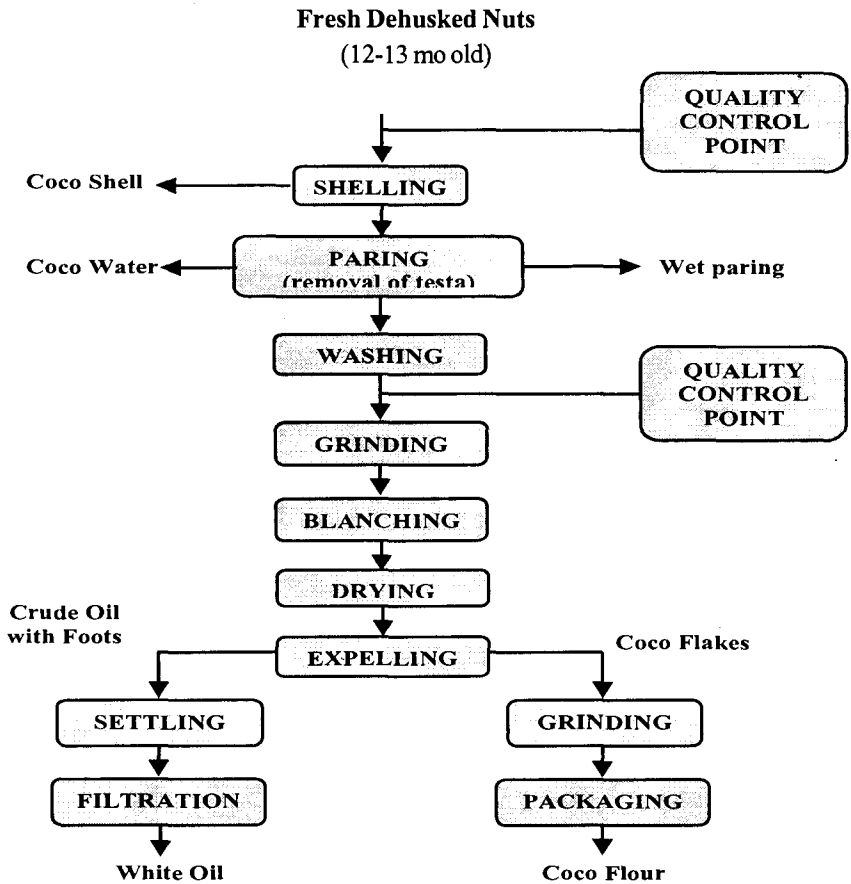

Fig. 1. Fresh-dry process: desiccated coconut route of VCO production.

Fresh-Dry Process, Grated Coconut Route involves splitting of nut, grating, blanching and drying the coconut meat and then extracting the oil using a screw type press to produce VCO and full protein, medium-fat coconut flakes (Fig. 2). The flakes are ground to produce coconut flour.

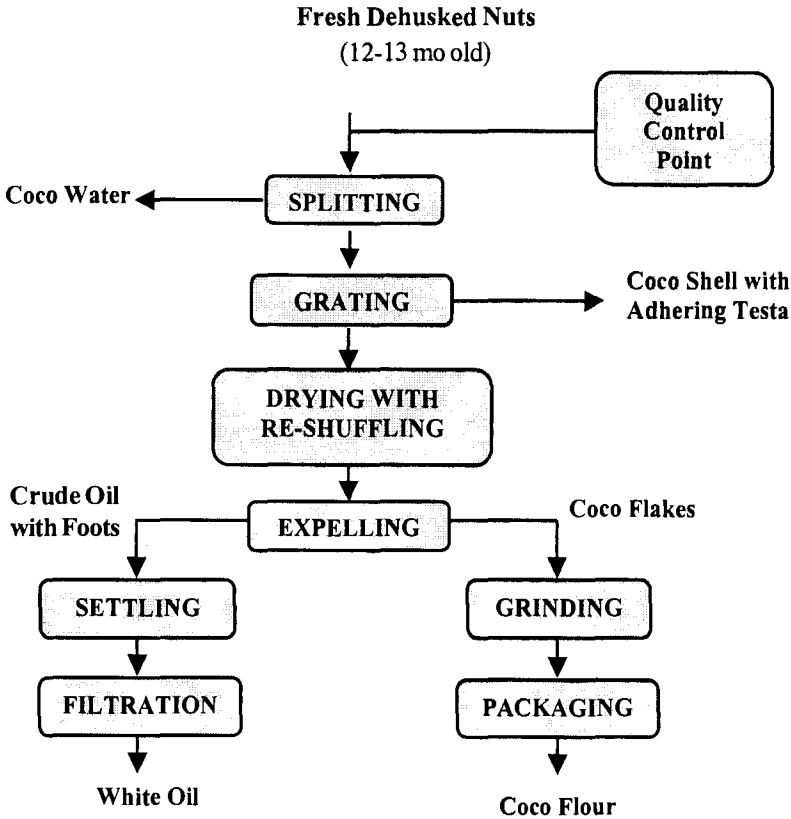

Fig. 2. Fresh-dry process: grated coconut route of VCO production.

Fresh-Dry, Wet Milling Route involves de-shelling the meat either manually or mechanically by a de-shelling machine, splitting, slicing, washing, grinding or wet milling, drying of particulated meat and extracting the oil using a screw press (Fig. 3). Coconut flour with testa can be an added product by further grinding the flakes. Modification made by a VCO plant wherein the fresh meat is dried under vacuum using oil as medium prior to expelling. The advantage of this process is the greater volume of products produced over time and the use of low heat for safe handling of materials.

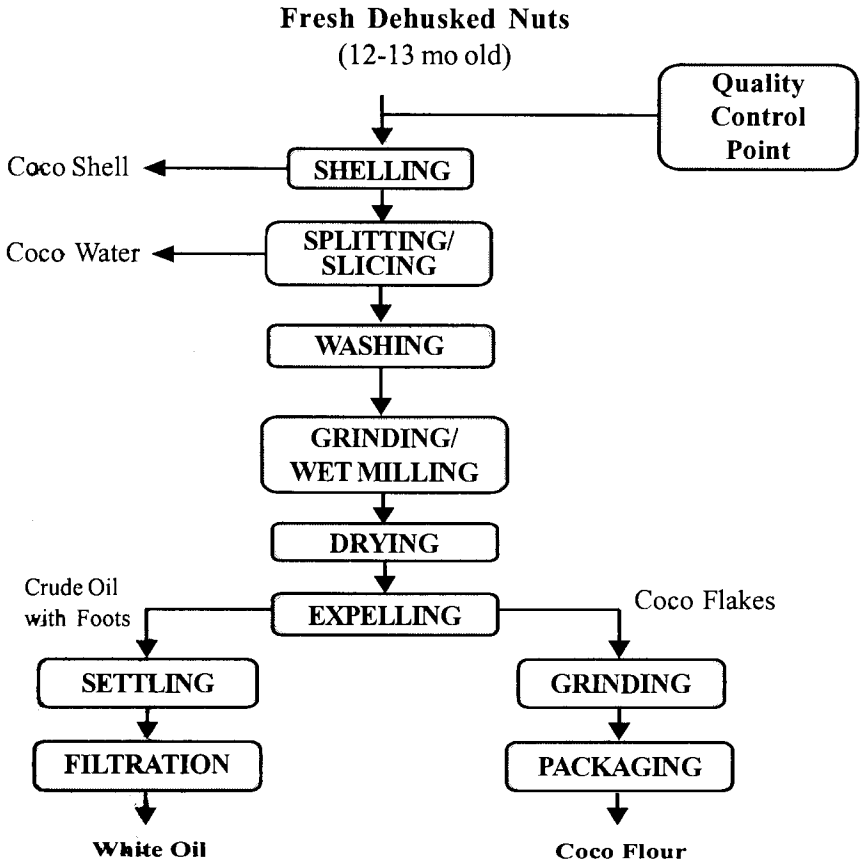

Fig. 3. Fresh-dry process: wet milling route of VCO production.

Wet process

Fermentation Process involves splitting the nut, grating the meat to fine particles, squeezing the milk either manually or mechanically with or without the addition of water (Fig. 4). The milk is allowed to ferment for 18 hr. During fermentation, transformation of sugars present in coconut milk to lactic acid by bacteria takes place. The bacteria produce enzymes which can hydrolyze proteins changing them to water-soluble amino acids. If this type of bacterium is allowed to act on coconut milk under favorable conditions for growth and multiplication, free oil appears on the surface. The oil that separates is scooped out and filtered and the cream which still contains part of the oil is gradually heated to further recover some oil. The skim milk at the bottom is discarded. Ambient temperature condition is favorable for fermentation to take place.

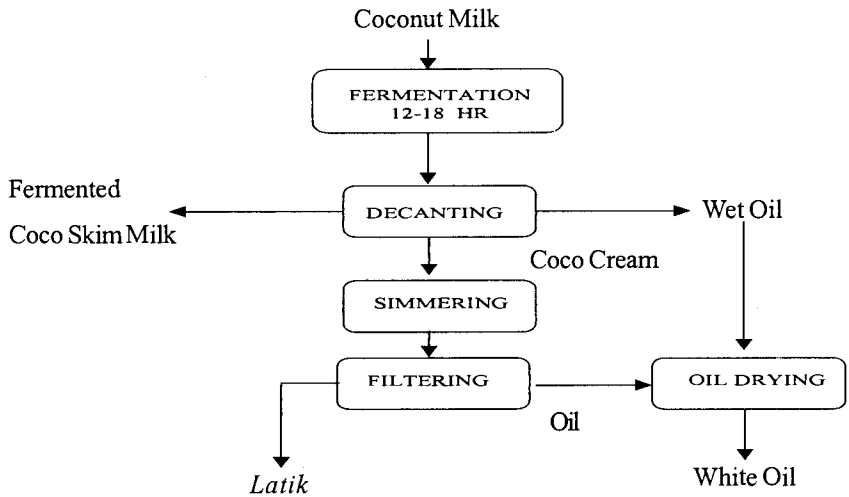

Fig. 4. Fermentation process for VCO production.

Centrifuge process involves splitting the nut, grating the meat, squeezing the milk manually or mechanically with or without the addition of water (Fig. 5). The milk is passed through a two-way centrifuge equipment to separate the cream from the skim milk. The cream is boiled or heated in atmospheric temperature or under vacuum to recover the oil. A 3-way centrifuge process is also being used by other VCO plants to separate the liquid from the solids. This process was initially developed by Robert Hagenmaier et al in 1973. Later, the Industrial Technology Development Institute-DOST pursued its work on this process which is now currently used during training on virgin coconut oil production.

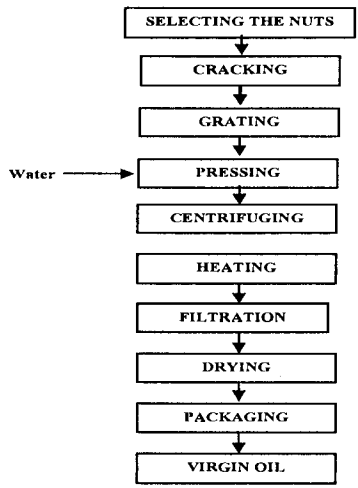

Fig. 5. Centrifuge process for VCO production.

Enzymatic process involves the extraction of coconut milk from freshly grated coconut meat with the addition of water (Fig. 6). The process involves treatment of coconut milk with proteolytic enzymes to separate the oil and protein curds. The cream and oil are passed through centrifugation process to obtain the coconut oil. The oil is then filtered, bottled and packaged.

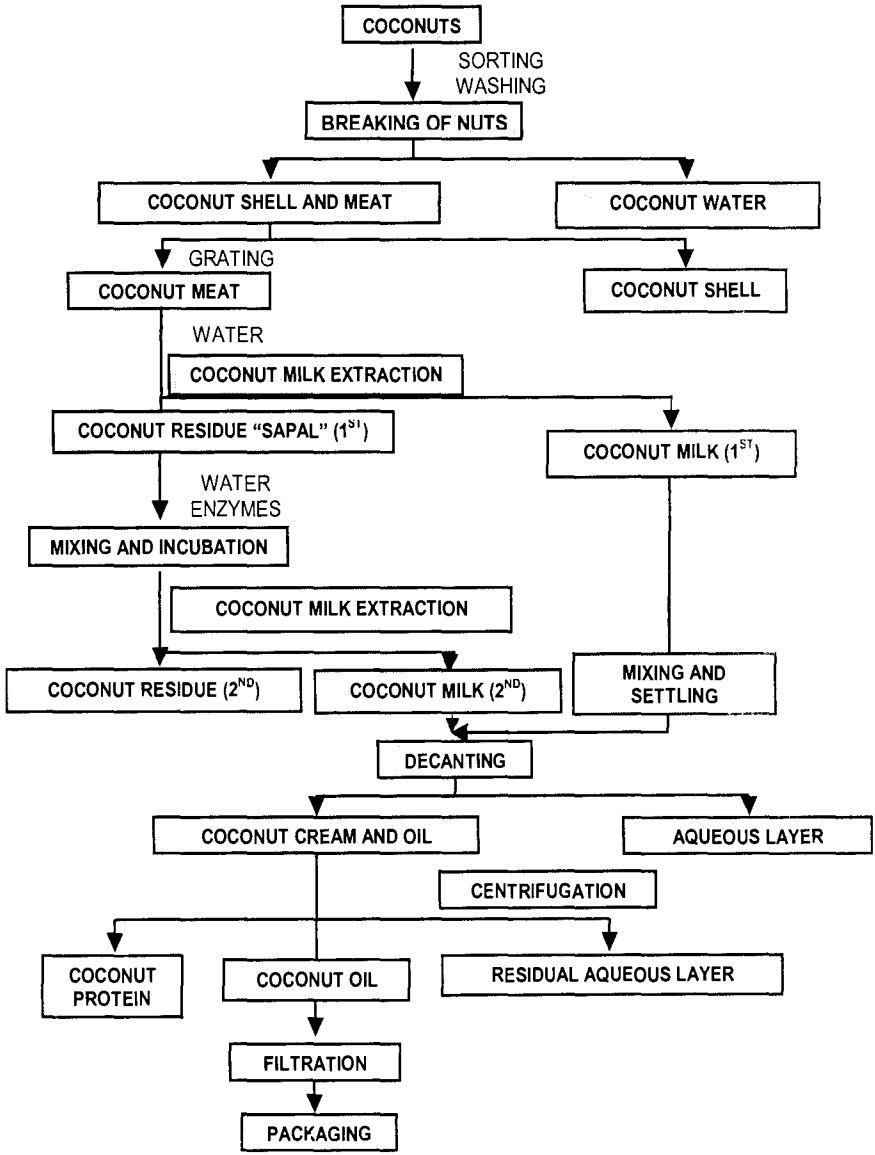

Fig. 6. Flowchart of the enzymatic process for VCO production.

Dry and Wet Process (Bawalan-Masa process) is a combination of dry and wet processes developed by Engr. Divina Bawalan, former Senior Science Research Specialist and Ms. Dina B. Masa, Manager, Product Development Department, PCA. The process involves blanching and drying the residue obtained from fresh coconut meat after milk extraction (Fig. 7). The dried residue is defatted under controlled conditions using an expeller with a cooling system to produce virgin coconut oil and flakes. Note that the residue still contains 35-40% oil content. The oil produced has a free fatty acid content ranging from 0.01-0.10%. It meets the other quality requirements for VCO. The flakes can be further ground to produce high fiber-coconut flour with low fat content.

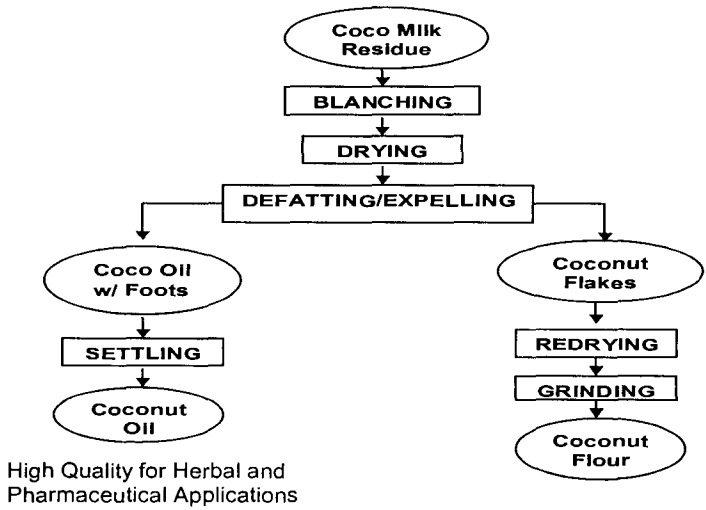

Fig. 7. Bawalan-Masa process for VCO production.

It can be observed that existing VCO production technologies mainly differ in the oil/milk extraction processes, moisture content reduction techniques and filtration processes. Some technologies used mechanical or manual oil/milk extraction methods and moisture content removal of fresh grated meat by drying in hot air or under negative pressure. Others reduce moisture content of oil either by settling, heating or applying negative pressure. The filtration is done manually using filter paper or mechanically using a pressure filter or ceramic filter cartridge.

With the existing processes adopted by VCO producers, a collective production capability of more than 270 mt/mo was estimated and a monthly projection of 1,000 mt. It was also estimated that in microscale production of VCO from 15 fully mature nuts recovery is equivalent to one liter of VCO. Thus, to produce the projected monthly production of 1,000 mt, a total of 16,304,347 nuts is required. Table 2 shows the estimated monthly

capacity per process and the monthly projection as reported by the producers.

Table 2. Estimated monthly capacity and projection of VCO production as classified per process. 2006 (VCO Philippines, 2005).

Process	Estimated monthly production capacity	Projected monthly capacity
Expeller pressed		
Desiccated route	Over 150 mt	300 mt
Expeller pressed	Over 50 mt	500 mt
Fermentation/Enzymatic & Variant processes for moisture content removal	Over 50 mt	100 mt
Centrifuge process & variant processes for moisture content removal	Over 20 mt	100 mt

While VCO quality and oil recovery differ for every process, each has its own respective advantages and limitations. Table 3 shows the differences and cost of producing the VCO. It appears that VCO pricing would vary depending on the cost of production. In the case of centrifuge process, it entails high equipment cost whereas the other processes will have lesser cost, thus, results to high discrepancy in pricing of the product. Another factor is the economy of scale in which high capacity reduces production cost. Thus competition will be on the quality of the product, product labeling and market promotion.

Table 3. Comparative assessment of different processes for producing VCO (PDD-RDEB PCA, 2006).

Process	**Capacity (nuts/d)**	**Products**	**Investment cost (in PhP)**	**Production cost (in PhP/L)**
Fresh-Dry Process (Grated Nut Route) Method	500 nuts	VCO and cocoflakes	1,230,000	83
	1,000 nuts		1,523,000	65
	2,000 nuts		2,469,000	65
Modified Fresh-Dry Process	2,600 nuts	VCO, vinegar and cocoflakes	3,500,000	60 to 70
Fermentation Method	600 nuts	VCO and coconut meal	790,000	161
Centrifuge Process (ITDI-DOST)	500 nuts	VCO and coconut meal	2,214,000	320
Modified Centrifuge Process (C-VAC)	5,000 to 10,000 nuts	VCO and coconut meal	5,000,000	150 to 200
Bawalan-Masa (PCA) Process	500 kg of residue (*sapal*)	VCO and cocoflakes	890	35

In terms of quality, only the producers claim that respective VCO produced by each process has its own characteristics (i.e. color, taste and shelf-life). Research studies are underway to support the biochemical variation of the VCO produced by these processes. So far, all the VCOs produced from the above-mentioned processes passed the PNS and BFAD certification and are available in the market.

Opportunities

As a result of its increasing demand in the niche market, many have ventured into virgin coconut oil production, mostly on a small scale. As such, more jobs were generated and the nut requirements of the VCO plants improved the farm income of the coconut farmers. However, pricing of nuts should be regulated to ensure that the farmers will be benefited. With the increasing demand of the VCO in the domestic and international market, the declining status of the coconut industry changed its trend and started to gain economic advantage. For the farmer, the uncertain and wavering income from coconuts was stabilized through the increasing demand for nut supply. Enhanced by the boom of VCO, which shows signs of becoming the promising export coconut-based product, farmers have become more interested in planting coconuts.

Other than the consumption of VCO as food supplement, its utilization in the production of health and high-end and natural products is a plus factor to be competitive in the niche market. Soaps, lotions, massage oils, beauty creams and lipsticks are some of the VCO-based products that are already available in the market.

Export Performance

The Philippines still ranks as number one in the global market of vegetable oil and similarly with VCO, the country is the top exporter among coconut-growing countries. Thus, the quality of VCO has to be sustained to protect the industry. To realize this, quality standards and good manufacturing process have to be strictly implemented in order to conform with the domestic and internationally accepted product standards for VCO.

The Philippine Coconut Authority (PCA) recorded VCO exports from 1.80 to 475 mt from 2001-2005 with a mean value FOB US$ 857,457 (Table 4). In 2005, a total volume of 475 mt equivalent to FOB US$ 1,612,323 (PCA, 2006) was exported to major countries, in particular to the United States.

Table 4. Annual export performance of Philippine virgin coconut oil, 2001-2005 (PCA, 2006).

Year	Volume (in mt)	% Increase	Value (FOB US$)	% Increase	Unit price (US$/mt)
2001	1.80		19,810		11,005.56
2002	19.11	961.67	91,618	362.48	4,794.24
2003	102.83	438.10	406,580	343.78	3,953.90
2004	176.60	71.74	553,469	36.13	3,134.03
2005	475.30	169.14	1,612,323	191.31	3,392.22
Mean	**251.58**	**226.32**	**857,457**	**190.41**	**3,493.38**

In 2005, the bulk of exports of VCO (93.79%) was to the USA followed by Australia with only 1.9% share (Table 5). The increasing number of destinations was only realized in early 2006, as increasing demand for Philippine VCO in other countries like Canada was recorded (PCA, 2006). The total value from VCO exports is US$ 1.6M which is almost 0.2% of the total export income from coconut (estimated to be US$ 600 M). So far, the Philippines is still the number one supplier of VCO in the global market. Other VCO producing countries, Thailand and Indonesia, are fast moving in product development to be able to compete with our VCO. Thus, market positioning of our VCO has to be assured through quality and price competitiveness to maintain our present status. These can be achieved through concerted efforts of the concerned agencies with the necessary government support. Thus, of utmost priority for the industry is to increasingly fund research and development on processing technologies and for conducting more extensive medical studies to support the claims on various health benefits of VCO. Expanding our export markets is also an effective strategy to develop the VCO industry that will revitalize the dwindling coconut industry. Market strategies and product promotion are equally important to sustain the market demand for this promising product.

Constraints/Problems in VCO Production

The current problem of the VCO industry is on how the benefits of the industry will directly benefit the marginalized sector of the industry—the coconut farmers. The currently high-priced coconut-based product both in the domestic and export markets did not make a difference in terms

of its contribution to the increase in income of the coconut producers. The perennial problem of the coconut industry as in the case of copra trading is

Table 5. List of countries and volume of export destination of Philippine virgin coconut oil in 2005 (PCA, 2006).

Destination	Volume (in mt)	Value (in US$ FOB)	% Share
Australia	9.04	25,631.00	1.90
Canada	0.70	5,760.00	0.15
Germany	2.42	9,644.00	0.51
Hongkong	0.28	1,530.00	0.06
Ireland	6.22	24,626.00	1.31
Korea	3.09	4,113.00	0.65
Malaysia	1.49	9,574.00	0.31
New Zealand	0.56	1,494.00	0.12
Saudi Arabia	0.50	4,919.00	0.11
Singapore	2.37	5,420.00	0.50
South Africa	0.20	2,268.00	0.04
Sweden	1.00	2,500.00	0.21
United Kingdom	1.64	6,943.00	0.35
United States	445.79	1,507,901.00	93.79
TOTAL	**475.30**	**1,612,323.00**	**100.00**

seen to occur just the same in VCO manufacturing, since the multilayered trading of the nuts from the farm to the oil/mill is also a common practice observed in bringing the nuts to the VCO processing plants. The price of the whole nut for VCO is the same as that of the nut purchased for CNO

mills by traders. As such, no additional direct benefit for the coconut farmers occurs despite the economic opportunities for the VCO manufacturing.

Another limitation is the unregulated and fast growing establishment of the VCO plants that might pose a nut supply competition with other coconut-based industries such as desiccated coconut plants and oil mills. The strategic positioning of these manufacturing plants has to be mapped out in relation to the production capacity of the target site. Moreover, the pricing system of the VCO and the classification of the product based on the process were not given emphasis. This will require economic and marketing studies and possible review of the PNS to be able to come up with a vigorous grading system for the VCO.

Institutional Efforts and Action Programs for VCO

With the current issues affecting the industry and to be able to realize the expected impacts, there is a need to pool resources and strategize to achieve a sustainable development of the VCO industry. Major agencies in the country are dealing with these issues such as:

Philippine Coconut Authority (PCA)

1. Export regulation to sustain the present competitive advantage of VCO in the international market.
2. Strict implementation and monitoring of the PNS compliance to protect the VCO quality.
3. Regulation of the establishment of VCO plants in strategic locations for fair competition in the VCO market and to establish equal distribution of opportunities among key players.
4. Accreditation of government and available private laboratories in various locations for VCO quality analysis.
5. Promotion campaign on replanting and planting programs that will address the declining nut production and increasing competition in the supply of nuts among the coconut-based industries.
6. Coordination with other agencies and key players in the supply-value chain of VCO production to lessen production cost.

Department of Science and Technology (DOST)

1. Creation of the National Committee on Coconut Oil Research for Health with technical working committees spearheaded by NAST.
2. Funding support on the validation program for the quality and health claims of VCO.

3. Development of VCO related basic technologies, processing and health concerns.
4. Dissemination of scientific information through Information, Extension and Communication (IEC) materials and conduct of seminars and symposia.

Bureau of Food and Drug (BFAD)

1. Licensing of VCO producers to ensure quality and safe products for human consumption.
2. Formulation and development of the PNS in collaboration with PCA and BAPS.
3. Monitoring and regular inspection of licensed VCO plants for GMP and HACP compliance.

Department of Trade and Industry

1. Price regulation and development of effective trading system for VCO.
2. Development of collective marketing for small-scale producers engaged in VCO production.
3. Establishment of linkages with domestic and export markets.
4. Protection of small-scale VCO producers from large-scale companies in the marketing or trading system.

Conclusions

The popularity of VCO as functional food and its vast uses in producing high end products such as cosmetics, lotions etc. created a fast developing niche market. The present market status and the increasing trend of export performance of VCO can revitalize the dwindling coconut industry. Moreover, the attractive business of VCO as income-boosting industry to Small and Medium Enterprise (SMEs) will eventually improve the livelihood of the VCO producers and the coconut farmers.

With the available simple, low-cost VCO processing technologies, production in a small business enterprise, direct participation of coconut farmers in a household or community scale can be realized. This would mean a larger share from the benefits that can be derived from the industry.

On the macroeconomic level, the export share is highly significant. As reported (1994-2004) the international price for copra-derived oil was US$ 582/mt (UCAP Statistics), while the recorded export price for VCO (2004) was US$ 3,134/mt (PCA)(Table 4). Comparatively, this will be equivalent to a value addition of 500% (Bawalan and Chapman, 2006).

Market promotion, research on product development, medical studies and assurance of product quality should be the focus of government's support to the industry. Nevertheless, the government institutions should also work closely with the private sectors to have concerted efforts in moving forward to protect this industry.

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Studies on Standards for Commercial Virgin Coconut Oil

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Abstract

A minimum set of analytical methods is recommended for the differentiation of virgin coconut oil (VCO) from refined, bleached and deodorized coconut oil (RBD CNO): % fatty acid composition, % moisture by Karl Fischer (0.10%), % volatile matter at 120°C (0.10-0.20%), % free fatty acids as lauric acid (0.2%), peroxide value (3 meq/kg), and microbial contamination by colony forming units (<10 cfu/mL). The % fatty acid composition was determined using an internal standard and molecular weight correction from the fatty acid methyl ester to the fatty acid. This method yields absolute amounts of fatty acid in the oil. The absolute amount of oleic acid and linoleic acid can be used to replace the iodine value. Principal components analysis of the fatty acid composition indicates that it is not affected by the processing method.

Introduction

The Philippines is the second largest producer of coconut products in the world. About 27% of total agricultural lands is planted to coconut and more than one out of every four Filipinos depends on the coconut for livelihood. Coconut oil accounts for largest share of products and virgin coconut oil (VCO) is the fastest growing product (PCA, 2007).

Coconut oil is derived from the kernel of *Cocos nucifera* L. Commercial cooking oil is prepared by chemical and/or physical refinement of the oil which is obtained from copra and is referred to as refined, bleached and deodorized coconut oil (RBD CNO). VCO, on the other hand is obtained from the fresh, mature kernel of coconut.

At present, the international standard for coconut oil is defined by Codex Alimentarius (2006). However, this standard is based on RBD CNO and may not be appropriate for VCO. Although Codex has a general definition for "virgin oils," it has no specific standards for VCO. The Asian Pacific Coconut Community (2006), on the other hand, promulgated an interim standard specific for VCO.

In 2004, the Bureau of Agriculture and Fisheries Product Standards, Department of Agriculture (BAFPS-DA), in collaboration with a multi-sectoral task force promulgated a Philippine interim product quality standard, PNS/BAFPS 22:2004, which defines VCO as: "Oil obtained from the fresh, mature kernel of the coconut by mechanical or natural means, with or without the use of heat, without undergoing chemical refining, bleaching or deodorizing, and which does not lead to the alteration of the nature of the oil. Virgin coconut oil is an oil which is suitable for consumption without the need for further processing."

The first challenge of the implementation of this standard is to develop the analytical parameters which can determine compliance with each requirement of the standard, in particular, how to differentiate between RBD CNO and VCO. In addition, the analytical methods used should be standard methods which are accessible and affordable.

The three standards—Codex (2006), APCC (2006) and PNS/BAFPS 22:2004—are compared in Table 1. It is worth noting the following: first, the Codex standard was set using coconut oil traded internationally, which is RBD CNO, while the APCC standard is specific for VCO; and second, there are a number of differences between Codex and APCC in some of the individual parameters.

Padolina et al (1987) wrote a comprehensive review of the available chemical and physical properties of coconut oil. This review included a discussion of the major and minor characteristics of coconut oil, including the fatty acid composition, a breakdown of the glyceride composition, phytosterols, tocopherols, volatile compounds, and various physical properties.

Table 1. Quality parameters from existing standards: Codex Alimentarius (2006) for coconut oil, APCC (2006) for virgin coconut oil, and PNS/BAFPS 22:2004.

Parameter	Codex Alimentarius (for coconut oil)	APCC (for VCO)	PNS / BAFPS 22:2004 (for VCO)
% Fatty acid composition			
C6:0	ND- 0.7	0.4 - 0.6	ND -0.7
C8:0	4.6- 10.0	5.0 - 10.0	4.6 - 10
C10:0	5.0- 8.0	4.5 - 8.0	5.0 - 8.0
C12:0	45.1 53.2	43.0 - 53.0	45.1 -53.2
C14:0	16.8- 21.0	16.0 - 21.0	16.8 -21
C16:0	7.5- 10.2	7.5 - 10.0	7.5 -10.2
C18:0	2.0- 4.0	2.0 - 4.0	2.0 - 4.0
C18:1	5.0- 10.0	5.0 - 10.0	5.0 - 10.0
C18:2	1.0- 2.5	1.0 - 2.5	1.0 - 2.5
C18:3	ND- 0.2	<0.5	ND -0.2
C20:0	ND- 0.2		---
C20:1	ND- 0.2		---
C20:2 – C24:1	ND		ND
Iodine value	6.3 – 10.6	4.1 – 11.00	---
Free fatty acid (% as lauric acid)	None	<0.5	0.20
Moisture (% weight, max)	---	0.1 – 0.5	0.2
Matter volatile at 105°C (%m/m)	0.2	0.2	0.2 (max)
Peroxide value (meq/kg oil)	<15 meq active oxygen/kg oil	< 3 meq/kg oil	3.0 meq/kg oil (max)
Microbiological contamination	---	<10 cfu/ml	

ND = not detected

Dia et al (2005) conducted a comparative physicochemical study on VCO and RBD CNO to determine whether these could be differentiated. They prepared VCO using three methods (desiccated coconut meat with incubation, coconut milk with incubation, and coconut milk-freeze-and-thaw) using three types of coconut meat (two varieties and one hybrid). In addition, they included six commercial VCO products and one RBD CNO product. Among the VCO samples, they found that although differences in chemical and quality properties were noted, these were not large enough to affect their overall quality.

The fatty acid composition of various coconut oil samples has been the subject of previous investigations. Banzon and Resurreccion (1979) reported that the manner of processing does not affect the fatty acid profile. On the other hand, Laureles et al (2002) observed that different varieties of coconut gave different fatty acid profiles, particularly in the C8 and C10 components.

Recently, there has been much concern regarding the presence of *trans*-fatty acids in fats and oils (see, for example: US FDA, 2007 and IFST, 2005). The major source of *trans*-fats is partial hydrogenation and high temperature processing of polyunsaturated vegetable oils, such as corn and soya oils.

There are two methods used for the determination of *trans*-fatty acids: infrared spectroscopy and gas chromatography. IR spectroscopy is simpler but it is not accurate below 5% and is subject to interferences. GC analysis of fatty acid methyl esters (FAMEs) is more accurate, but prior silver-ion TLC separation is recommended for oils with high levels of polyunsaturated fatty acids (Leatherhead Food International, 2006). Because coconut oil contains less than 10% total unsaturated fats (oleic acid and linoleic acid), direct GC analysis after methylation is adequate.

Table 2 is a compilation of all the Codex analytical parameters for vegetable oils and the type of information that can be obtained from these. For this work, we selected the minimum set of analytical parameters which is necessary to identify the vegetable oil and which can differentiate between RBD CNO and VCO.

The standard methods from Codex Alimentarius were reassessed using appropriate reference compounds and internal standards. Response factors, spiking and % recoveries were performed. The following standard methods were performed: % fatty acid profile, % moisture by gravimetric method and by Karl Fischer method, iodine value, % free fatty acid (as lauric acid), peroxide value, and microbial contamination (by colony forming units, cfu). Table 3 lists the analytical parameters which were included in this study. Finally, principal components analysis (PCA) was carried out on the results in order to determine whether multivariate groupings and correlations exist among the samples or parameters. The samples used in this study included RBD CNO, VCO and copra oil.

Table 2. Classification of the Codex analytical parameters according to their utility and the type of information that they provide (Codex 2006).

Analytical parameter	Indicator for:		Type of information:		Comments
	Row material	Process	General	Molecular	
% Fatty acid composition	✓			✓	Coconut oil is a unique vegetable oil having 70% medium chain fatty acids and 10% total unsaturated fatty acids
Heavy metals, Pb, As, Fe, Cu		✓			
Microbial contamination		✓			
Matter volatile at 105°C		✓	✓		This test combines loss of moisture and volatile organic carbon compound (VOCs)
Insoluble impurities		✓	✓		
Soap content		✓	✓		
Acid value/%Free fatty acid		✓	✓		
Iodine number	✓	✓	✓		
Peroxide value		✓	✓		
Apparent density	✓		✓		
Refractive index	✓	✓	✓		
Sterols	✓	✓		✓	Over 8 sterols have been identified
Carotenoids, tocopherols	✓	✓		✓	Present in testa

Table 3. Analytical parameters which were used in this study.

Analytical parameter	Comments
1. % Fatty acid profile by GC (FID)	• Used C11 FA and FAME as IS. • FAME to FA molecule weight correction. • Used C18:1*t*13 as *trans*-FA standard.
2. Iodine value	Determined % recovery using C18:1 and C18:2.
3. % Moisture by Karl Fischer	• Not included in Codex and APCC. • Determined % recovery.
4. % Matter volatile	• Raised temperature from 105 °C to 120 °C. • Determined % recovery.
5. Peroxide number	
6. % Free fatty acid, as C12	Determined % recovery.
7. Microbial contamination	Colony forming units, cfu.

Experimental

Coconut oil samples. Samples of virgin coconut oil were provided by members of the Virgin Coconut Oil Producers and Traders Association of the Philippines (VCO Philippines) or were purchased from commercial outlets. Copra oil samples were supplied by the Philippine Coconut Authority. Samples of RBD CNO were purchased from supermarkets and were provided by Spring Oil Co.

Twenty samples were analyzed: commercial VCO (n = 13), copra oil (n = 3), and RBD CO (n = 4). The 13 commercial VCO samples are broken down into the following types: expeller process (n = 4), enzymatic (n = 2), fermentation with heating (n = 2), fermentation without heat (n = 2), and centrifuge (n = 3).

Determination of % fatty acid composition and *trans*-fatty acids in coconut oil by gas chromatography. The % fatty acid composition of the coconut oil samples was determined by methylation of fatty acids using the boron trifluoride method to produce the fatty acid methyl esters (FAMEs), followed by GC analysis (AOAC 1995 Official Method 969.33/963.22). One µL of FAME extract was then injected into a Shimadzu GC-14B gas chromatograph equipped with flame ionization detector (FID). Separation was done on a DB-1 capillary column (J&W Scientific, polydimethylsiloxane, 60m x 0.25mm i.d. x 0.25 µm film thickness) with the following oven temperature program: initial temperature at 60°C, held for 6 min; increased to 180°C at 5°C/min, held for 2 min; increased to 210°C at 5°C/min, and increased to 230°C at 1°C/min, held for 5 min. The injector and detector temperatures were set at 210°C and 230°C, respectively.

The individual GC response factors for C8ME, C12ME, C18:0ME, C18:1*c*9ME, C18:2*c*9,12ME and C18:1*t*13ME versus the C11ME internal standard (IS) were determined within the expected concentration range for each fatty acid. The response factors for the other saturated FAMEs were obtained by extrapolation. The %FAME composition for each sample was converted to %FA composition (w/w) by molecular weight correction. GC analysis of samples was done in duplicate.

Confirmation of the identities of the FAME compounds, as well as the presence of *trans*-fatty acids was done by GC-MS using a Hewlett Packard 5890 Series II gas chromatograph coupled to a Finnigan MAT95 mass spectrometer, using an identical GC capillary column and oven program parameters. MS analysis was carried out by electron ionization at 70 eV, scanning from m/z 35 to 350.

Iodine value. This procedure is based on AOAC (1995) Official Method 920.158. The completeness of this method was determined by measuring the % recovery of the reaction. Using oleic acid and linoleic acid, the % recovery was determined to be 92% and 85%, respectively. Analysis of samples was done in duplicate.

Moisture content by Karl Fischer titration. This procedure is based on AOAC (1995) Official Method 984.20. The moisture content of the VCO samples was determined in duplicate using a Metrohm 785 DMP Titrino Karl Fischer titrator. This instrument can detect 500 μg water (Metrohm 785 manual), giving a detection limit of 0.005%. Spiking with water gave a recovery of 102%.

Moisture content by gravimetric analysis. Codex (2006) stipulates a gravimetric procedure using oven drying at 105°C (ISO 662:1998). However, comparison of results from Karl Fischer determination indicated that a higher temperature may be required for some samples. Therefore, a parallel determination using oven drying was performed at 120 °C. Coconut oil spiked with known amounts of water gave an average recovery of 108%. The method detection limit was determined to be 0.05%. Analysis of samples was done in duplicate.

Free fatty acids as lauric acid. This procedure is based on AOAC (1995) Official Method 940.28. Recovery of the method was 83%, which corresponds to the difference of one drop of titrant. Analysis of samples was done in duplicate.

Peroxide value. This procedure is based on AOAC (1995) Official Method 965.33. The minimum detectable amount was 0.1 meq/kg. Analysis was done in duplicate.

Microbial contamination. The determination of microbial contamination was carried out by the Microbiology Section, Natural Science Research Institute, University of the Philippines, Diliman. The colonies appearing per plate were counted and the number of colony-forming units (cfu) per mL reported.

Principal components analysis. Chemometrics analysis was performed using The Unscrambler™ (CAMO Process AS, Oslo, Norway). The data were first normalized and standardized before Principal Components Analysis (PCA) was carried out.

Results and Discussion

Coconut oil samples

The VCO samples were selected to represent the various methods, which are currently used by various VCO manufacturers. The samples were actual products of the VCO producers. The results therefore represent the range of values, which the various processes yield.

Coded samples were submitted by the VCO Philippines and were selected to assess the following parameters: type of process, inclusion of testa, wet/dry, use of heat, and source of nuts. Production conditions, such as age of nut, manner of handling, temperature and time of processing were not controlled. The sources of nuts of the VCO samples were

Batangas, Laguna, Quezon and Davao. The RBD CNO samples were obtained from commercial sources and the copra oil samples were sourced from Zamboanga, Davao and Lucena.

Fatty acid composition

The % fatty acid composition is the most important parameter used to differentiate the various vegetable oils. The GC response factor for each FAME standard was obtained versus the IS at the expected composition level. For example, the response factor for methyl laurate was determined by averaging the response factors of 5 solutions within the range 40 to 60%, while the response factor for methyl stearate was determined within the range 0 to 5%. The %FAME content of each sample was determined using the IS, and the %FA composition was calculated by molecular weight correction. The average values and the range of values are compared on Table 4 against the Codex and APCC (2006) values.

The %FA composition of the coconut samples generally fell within the Codex and APCC standards, with slight variances for C6, C8, and C10.

Principal components analysis (PCA) was applied to the %FA composition data to determine whether there is a correlation between %FA composition and type of sample. The PCA scores plot (Fig. 1) indicates that there is no correlation between %FA composition and type of sample. The %FA composition therefore cannot be used to differentiate among the various processing methods. This is consistent with the earlier observations of Banzon and Resurreccion (1979).

GC results from simple area integration and normalization gives only relative %FAME composition, and the values differ slightly from those we obtained. For example, %C12ME is up to 2% higher while lower values are obtained for shorter and longer chain FAMEs.

***Trans*-fatty acids**

In this study, C18:1*t*13 was selected as the *trans*-fatty acid reference compound. Calibration solutions were prepared down to 0.01%. Analysis of the coconut oil samples by GC-MS did not detect the presence of C18:1*t*13 or any other mono-unsaturated C18 fatty acid, apart from C18:1*c*9, down to the 0.01% level. Thus, one can conclude that VCO and RBD CNO do not contain *trans*-fatty acids.

Iodine value

The iodine value is the percentage by weight of molecular iodine, I_2, absorbed by an oil and is a standard procedure for determining the amount of unsaturation in an oil sample. This test involves the addition of iodine to double bonds, although small quantities of substitution products may be

Table 4. % FA using internal standard and molecular weight correction, and comparison with Codex Alimentarius and APCC standards.

	Fatty acid (% w/w)								
	C6:0	**C8:0**	**C10:0**	**C12:0**	**C14:0**	**C16:0**	**C18:0**	**C18:1c9**	**C18:2c9,12**
Standard									
Codex Alimentarius (2006)	ND–0.7	4.6–10.0	5.0–8.0	45.1–53.2	16.8–21.0	7.5–10.2	2.0–4.0	5.0–10.0	1.0–2.5
APCC (2006)	0.4–0.6	5.0–10.0	4.5–8.0	43.0–53.0	16.0–21.0	7.5–10.0	2.0–4.0	5.0–10.0	1.0–2.5
Samples									
All CNO samples									
Average	0.35	6.70	4.97	48.82	18.06	8.66	3.40	7.27	1.77
Range	0.23–0.49	4.15–8.30	4.17–5.75	46.0–52.6	16.0–19.7	7.65–10.1	2.86–4.63	5.93–8.54	1.00–2.36
VCO samples only									
Average	0.35	6.89	5.12	48.95	18.06	8.55	3.48	7.09	1.51
Range	0.24–0.49	4.15–8.30	4.27–5.75	46.0–52.6	16.0–19.7	7.65–10.1	2.86–4.63	5.93–8.53	1.00–2.16
RBD samples only									
Average	0.37	6.05	4.75	48.13	18.29	9.15	3.29	7.71	2.28
Range	0.32–0.43	5.32–6.82	4.56–4.90	46.7–49.4	17.6–19.6	8.82–9.73	2.94–3.69	7.24–8.04	2.14–2.36
Copra oil samples									
Average	0.34	6.74	4.61	49.16	17.77	8.50	3.23	7.49	2.16
Range	0.23–0.40	5.48–7.39	4.17–5.07	48.3–49.8	17.2–18.1	7.80–9.48	3.04–3.43	6.71–8.54	2.08–2.31

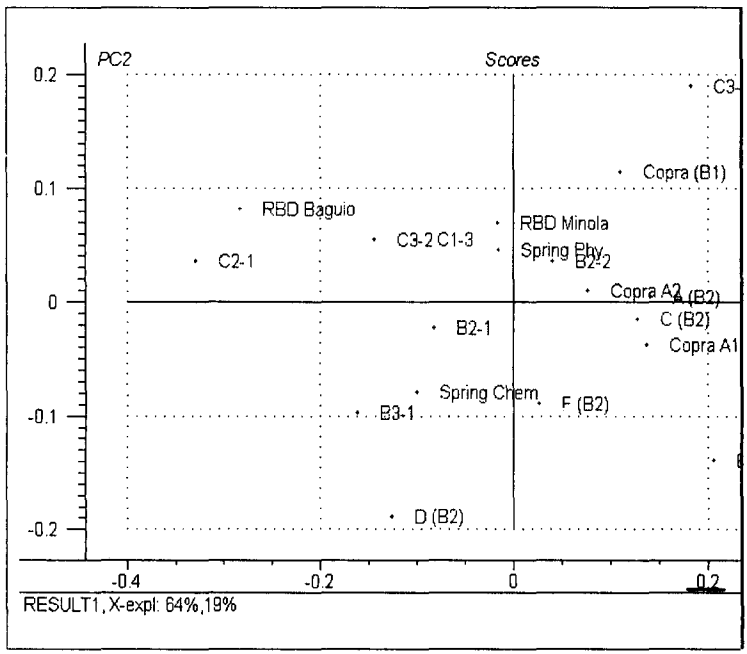

Figure 1. Principal Components Analysis (scores plot) of the % fatty acid composition in VCO and RBD CNO samples.

formed. Vegetable oils can be differentiated by the amount of I_2 that is absorbed (Kolthoff and Stenger, 1942). For coconut oil, the Codex (2006) range for iodine value is 6.3 to 10.6, while for APCC (2006) it is 4.1 to 11.0.

The iodine values obtained for the various coconut samples in this study ranged from 5.64 to 10.34 (Table 5). All of the samples complied with APCC (2006) but not with Codex (2006). Thus, for coconut oil products as a whole, the APCC standard for iodine value is more appropriate than Codex.

The results of the iodine value can be cross-checked against the %FA acid profile obtained by GC analysis (Table 6). Since the iodine value is a measure of total double bonds in an oil sample, the iodine value should be comparable with the GC results in the absence of other olefinic compounds. However, because the % recovery for the iodine value method is only 92% and 85% for oleic acid and linoleic acid, respectively, this indicates that the addition of iodine was incomplete. Therefore, the iodine value underestimates the number of double bonds and may depend on experimental conditions.

Table 5. Summary of results of analysis for quality parameters and comparison with Codex and APCC standards. (ND: none detected).

	Iodine value	Peroxide value	Volatile matter at 120°C (% w/	Karl Fischer moisture (%)	FFA (% as lauric acid)	Microbial contamination (cfu/mlmL)
Standard						
Codex Alimentarius	6.3–10.6	15	0.2*	-	-	-
APCC (2006)	4.1–11.0	<3	0.2*	-	<0.5%	<10
Samples						
All CNO samples						
Average	7,24	0.74	0.399	0.081	0.304	
Range	5.64–10.34	ND–2.80	ND–1.91	0.017–0.144	0.011–2.502	<10–<250
VCO samples only						
Average	7.10	0.55	0.147	0.080	0.134	
Range	5.64–10.34	ND–1.40	0.12–0.18	0.049–0.121	0.042–0.329	<10–<250
RBD samples only						
Average	7.92	0.78	ND	0.02	0.029	
Range	6.81–8.91	0.30–1.19	-	0.02	0.011–0.074	<10–<250
Copra oil samples						
Average	6.94	1.49	1.91	0.114	1.405	<250
Range	6.61–7.31	0.72–2.80	1.91	0.079–0.144	0.645–2.502	<250

* Codex Alimentarius and APCC specify that % matter volatile should be determined at 105 °C.

Table 6. Number of milliequivalent double bond / g of coconut oil from GC and Iodine value.

	% FA from gas chromatography				Iodine value method	
	meq double bond/g			Iodine value (theoretical from total meq double bond)	Iodine value (exptl.)	meq double bond/g (calc. from iodine value)
	C18:1	C18:2	Total meq double bond/g (exptl.)			
All CNO samples						
Average	0.23	0.11	0.34	8.58	7.24	0.29
Range	0.18–0.28	0.08–0.15	0.26–0.44	6.33–11.05	5.64–10.34	0.22–0.41
VCO samples only						
Average	0.22	0.09	0.32	8.04	7.10	0.28
Range	0.18–0.27	0.8–0.13	0.26–0.34	6.33–9.97	5.64–10.34	0.22–0.41
RBD samples only						
Average	0.24	0.14	0.38	9.59	7.92	0.31
Range	0.22–0.25	0.13–0.15	0.35–0.44	8.99–10.24	6.81–8.91	0.27–0.35
RBD samples only						
Average	0.24	0.14	0.38	9.53	6.94	0.27
Range	0.21–0.28	0.13–0.15	0.34–0.44	8.68–11.05	6.61–7.31	0.26–0.29

These results suggest that the quantitative GC profile of oleic acid and linoleic acid can replace the iodine value.

Peroxide value

The peroxide value measures the oxidative deterioration of fats and oils which takes place principally through reaction of the double bonds. The peroxide value is expressed in meq active oxygen (peroxide) per kilogram of oil sample (Gunstone, 1996).

Codex gives a peroxide value limit of 15 meq/kg for virgin oils, while APCC specifies 3 meq /kg oil for VCO. All of the VCO samples in this study were well below the APCC (2006) limit giving a range of values from none detected to 1.4 (Table 5). This indicates that VCO is stable to oxidative rancidity and that oxidation is not a significant cause of degradation. To ensure quality, the lower APCC (2006) standard of 3 meq/kg is recommended for VCO.

Moisture content

Moisture is an important factor which determines the product quality of the VCO. High moisture increases hydrolysis, which leads to a higher free fatty acid content and hydrolytic rancidity. The Codex standard specifies the gravimetric method and stipulates a maximum loss of 0.2% upon heating at 105°C. Because the difference in weight after heating corresponds to the loss of both water and volatile organic compounds (VOC), this is an inappropriate method for moisture determination.

Copra oil samples required over 4 d of heating with unsatisfactory results. The gravimetric method was therefore repeated at 120°C, with more reproducible results. The method detection limit of the gravimetric method using 5 g of oil sample (ISO 662:1998) is 0.05%.

The weight loss of VCO samples upon heating to 120°C ranged from 0.12 to 0.18%, while for RBD CNO samples, it was close to the method detection limit of 0.05%.

Karl Fischer titration is a widely used method for the direct determination of water content in oils (Hahn, 2006). Using KF titration, the moisture content of the VCO samples ranged from 0.05 to 0.12%, while for RBD CNO, the value was around 0.02% (Table 5).

The amount of VOC can be determined from the following relationship: % VOC + % Moisture = % Volatile Matter.

Thus, by subtracting the % moisture by Karl Fischer from the % volatile matter, we can obtain the weight due to VOC. If % moisture is 0.10% (the allowable limit), VOC should be 0.02 – 0.10%. (Fig. 2)

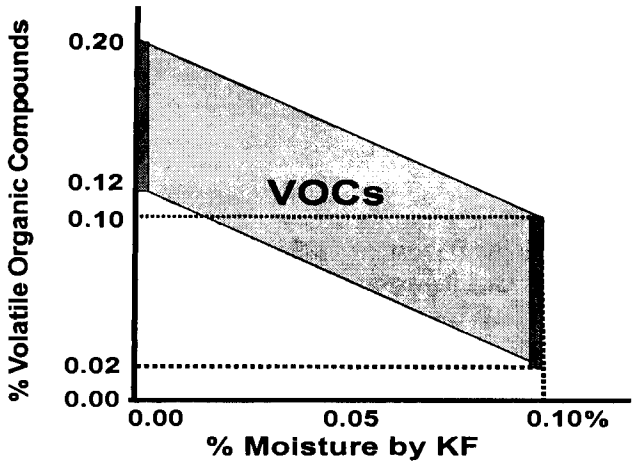

Figure 2. The amount of volatile organic compounds (VOCs) can be determined from the following relationship: % VOC + % Moisture = % Matter volatile. If KF moisture is 0.0%, VOCs should be 0.12 – 0.20%. If KF moisture is 0.10% (the allowable limit), VOCs should be 0.02 – 0.10%.

In the VCO samples analyzed, the VOC ranged from 0.02 to 0.08%; while in RBD CNO the VOC content was negligible. Thus, the VOC content can be used to differentiate VCO from RBD CNO.

Free fatty acids as lauric acid

Free fatty acids (FFA) are naturally present at low amounts in all vegetable oils. During extraction and storage, additional FFA may be formed by reaction with residual water in the oil. High levels of FFA are undesirable because of their unpleasant taste.

The APCC (2006) standard for FFA is 0.5% (as % lauric acid). In this study, the range of values obtained for VCO was 0.042 to 0.329%, while for RBD CNO samples the FFA were lower as would be expected (0.011 to 0.074%). All of the copra oil samples exceeded the 0.5% limit (data not shown). Thus, we can conclude that the VCO samples met the APCC (2006) standard for FFA. However, based on studies conducted by the Philippine Coconut Authority, a more stringent standard of 0.2% FFA was recommended, although the range was 0.01-0.32% (Gonzales, 2004).

Microbial contamination

The APCC standard is <10 colony forming units/mL. Failure to meet this standard indicates poor product quality, and is a potential health

hazard. Three of the thirteen VCO samples and all of the copra oil samples exceeded this limit (Table 5).

Conclusions and Recommendations

This paper sought to address two main questions: first, whether local VCO products meet the Codex (2006) standard for coconut oil and the APCC (2006) standard for VCO; and second, if VCO and RBD CNO can be differentiated using standard methods of analysis.

While the %FA composition of all the coconut oil samples analyzed generally fell within the Codex and APCC standards, some minor differences were noted. Also, the % FA composition cannot differentiate VCO from RBD CNO. In addition, it should be anticipated that if coconut varieties with higher lauric acid content are developed, an adjustment of the fatty acid profile may be needed.

The analysis for *trans*-fatty acids by GC using C18:1*t*13 as reference compound gave a negative result down to a detection level of 0.01%.

In terms of the other analytical parameters which were measured (% volatile matter, %FFA, iodine number and peroxide value), the VCO products were well within the standards.

The determination of total double bonds from GC analysis was generally comparable with the results from the iodine value method, but the results from the iodine value were lower by an average of 15% due to incomplete reaction. The GC ranges for unsaturated fatty acids are as follows: oleic acid: 0.18 – 0.28% and linoleic acid: 0.08 – 0.15%. GC analysis using an IS gives results which are comparable to the iodine value.

Three other recommended changes in the VCO standards are as follows: first, the inclusion of the moisture analysis by Karl Fischer method with the standard set at ≤0.10% moisture; second, a change in the temperature for determining volatile matter of 120°C instead of 105°C; and third, the total volatile matter for VCO should be within the range of 0.12 to 0.20% (w/w) which will account for both moisture and volatile organic compounds.

The Karl Fischer method is recommended because it is a direct determination of moisture content, which is a very important product quality indicator. The difference between the volatile matter and the Karl Fischer moisture gives the VOC content which should be between 0.02 to 0.10%. RBD CNO gives zero or very low values for this test, while copra oil gives higher values. The use of both methods in combination is the simplest strategy for differentiating VCO from RBD CNO and copra oil.

The recommended VCO standards are summarized in Table 7.

Table 7. Recommended quality standards for VCO.*

Parameter	Recommended quality standards
% Fatty acid composition	
C6:0	0.1–0.7
C8:0	4.0–10.0
C10:0	4.0–8.0
C12:0	45.1–56.0
C14:0	16.0–21.0
C16:0	7.5–10.2
C18:0	2.0–5.0
C18:1	5.0–10.0
C18:2	1.0–2.5
% Moisture content (w/w)	≤0.10
% Matter volatile at 120°C (w/w)	0.12–0.20%
% Free fatty acid (expressed as lauric acid)	< 0.2%
Peroxide value, meq/kg oil	≤ 0.30
Microbiological contamination per ml.	<10 cfu**

* These standards were approved after deliberation by the multi-agency task force chaired by BAFPS, with the participation of the Philippine Coconut Authority, the Bureau of Food and Drug, the National Academy of Science and Technology, the Department of Science and Technology, the VCO Association and the authors of this paper.
** The total aerobic microbial count should not exceed 100 cfu/mL, the total combined molds and yeasts count should not exceed 10 cfu/mL, and it should meet the requirements of the test for absence of *Salmonella* species and *Escherichia coli* (PNS/BAFPS 22:2004).

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3

Research on (Virgin) Coconut Oil Components — A Review

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Extended Abstract

Introduction. The presentation assumes that coconut oil, whether virgin (VCO) or not, possesses the same components that confer the health benefits attributed to the consumption of coconut oil. However, it does not rule out differences, perhaps in proportion, of these components, which might amplify or attenuate these benefits. Its main objective is to review key studies that provide insights as to what researchers need to focus on to provide data for use in standards refinement and application.

As defined in the 2004 Philippine National Standard for VCO, the process for copra oil production involves sun drying of the coconut meat. The changes that can take place during drying require subsequent refining, bleaching and deodorizing. Presumably, the more extensive processing leads to an alteration of the oil composition. Owing to its relatively low volatility, and the proportion in which it occurs naturally in coconut, it can be safely assumed that refined, bleached and deodorized (RBD) and virgin coconut oils are comparable in their lauric acid content.

In contrast, VCO production involves a rapid extraction of the oil from the meat. The quality of the oil can be affected by the process involved. On account of the manner in which VCO is consumed, palatability is a key parameter. Sensory characteristics resembling those of the fresh kernel would, of course, be desirable. The process defines moisture content, which affects the stability of the resulting oil. Aqueous extraction of the oil produces an emulsion stabilized by proteins (oleosins, Regalado et al, 2004) and complex carbohydrates. Microscopy reveals that progressive breakdown of and release of the triglycerides from the fat globules (Rosales, 2006). However, protein was not detected in the oil phase after centrifugation

(Chen and Diosady, 2003), suggesting that protein contributes little, if any, to the benefits of VCO.

Medium-chain triglycerides and fatty acids. Medium-chain triglycerides (MCTs) are fractionated coconut oil from hydrolyzed coconut oil with lauric acid (C12) removed, consisting mainly of caprylic (C8) and capric (C10) acids. MCTs were first used to treat lipid absorption disorders in 1950 (Bach and Babayan, 1982). MCTs enter directly into the portal vein, are transported directly to the liver to immediately provide energy, and not deposited as fat (Hashim et al, 1964; FAO, 1994). By contrast, long-chain fatty acids (LCFAs, ≥ C14 or longer) are esterified within the intestinal cells, enter the lymphatics and general circulation via very-low density lipoproteins to be utilized by the cells and deposited as fat. MCTs are hydrolyzed faster and medium-chain fatty acids (MCFAs) absorbed faster than LCTs and LCFAs.

Thermogenesis in humans is observed during overfeeding of liquid formula of MCTs than with LCTs, with greater energy expenditure (Hill et al, 1989). Enhanced postprandial energy expenditure with MCFAs feeding was attenuated in premenopausal women than with LCFAs (White et al, 1999). Exogenous lipid oxidation was higher on MCTs than on LCTs in both normal and obese women (Binnert et al, 1998). Replacement of dietary LCTs by MCTs increased energy expenditure and satiety and prevented body weight gain (St-Onge and Jones, 2002), even in overweight women (St-Onge et al, 2003a) and men (St-Onge et al 2003b). Adiposity is decreased St-Onge et al, 2003b) and body fat accumulation is suppressed in healthy men and women (Tsuji et al, 2001). Consumption of a functional oil rich in phytosterols and MCT improved plasma lipid profiles in men (St-Onge et al, 2003c). Brown adipose tissue (BAT) is essential for thermoregulatory thermogenesis: acute BAT activity or extra heat production is needed postnatally for entry into a febrile state and arousal from hibernation (Cannon and Nedergaard, 2004).

MCTs benefits are used to advantage in structured lipids and infant formula. Structured lipid has two short- or MCFAs and one LCFA attached to glycerol, which has reduced energy value about 8.3 kcal (35 J)/g and is useful for treating humans suffering from malabsorption of fat (Babayan and Barsky, 1969). Such reduced-energy fat also improves eating quality and heat resistance (Seiden, 1994), and are less likely to be stored in adipocytes (Akoh 1998). Other structured lipids are caprenin™, glycerol esterified with caprylic, capric and behenic acid, 5 kcal (21 J)/g (Ehrman et al, 1989) and salatrim™, glycerol esterified with at least one short-chain (C2, C3 or C4) and at least one LCFA (C18) (Wheeler et al, 1993). MCTs/MCFAs have been employed in total enteral and parenteral nutrition, preterm infant formulas, and improve calcium and magnesium absorption, especially

in infants and improve amino acid absorption (Odle 1997). Human milk FAs contain 6.3% lauric acid, but FAs of 67 kcal (281 J)/dL formulas contain 9.3-21.2% lauric acid, except Pregestimil™, the first nutritionally complete protein hydrolyzate formula containing MCT oil, a fat blend that is absorbed differently than the fat in other formulas, designed for babies with problems absorbing fat due to specific medical conditions, making it possible for them to absorb more fat. Enfamil™ and Similac™ had 20-30% of the fat as coconut oil (Nelson et al, 1998). Filled milk had coconut oil replacing butterfat as the oil component (Rice, 1960), which has been replaced by coconut oil:corn oil (9:1) blend.

Thus, VCO benefits are ascribed mainly to the natural lipid constituents of the mature coconut kernel, particularly MCFAs. *Codex Alimentarius* (2005) reports 4.6-10.0% caprylic, 5.0-8.0% capric and 45.1-53.2% lauric acid in coconut oil. Bragdon and Karmen (1960) reported that lauric acid partially follows the metabolism of MCFAs and LCFAs (Jandacek, 1994). However, differential oxidation of individual fatty acids in humans showed lauric acid had twice the oxidation rate of the higher LCFAs, including myristic acid, thus behaving as a MCFA (DeLany et al, 2000).

Lauric acid and monolaurin. Lauric monoglycerides and lauric acid have antimicrobial properties, together with the other MCFAs (German and Dillard, 2004). Glycerol monolaurate modulates immune cell proliferation in murine splenocytes (Witcher et al, 1996), inhibits *Listeria monocytogenes* (Wang and Johnson, 1992), *Helicobacter pyroli* (Petschow et al, 1996), toxin production by *Clostridium botulinum* in meat slurry (Notermans and Dufrenne, 1981), virulence factor production in *Bacillus anthracis* (Vetter and Schlievert, 2005), ruminal fermentation (Hristov et al, 2004), and citrinin production by *Monascus ruber* (Hajjaj et al, 2000). German and Dillard (2004) asked what is the optimum level of MCT intake?

Cuphea. The genus *Cuphea* (Lythraceae) are plants native to the New World, from Southern U.S. to Northern South America. Many species have potential as source of MCT. *C. painteri* has 73% caprylic, *C. carthagenensis* has 81% lauric acid and *C. koehneana* has >95% capric acid (Kleiman, 1990).

Authentication of VCO. Descriptive sensory evaluation of VCO and RBD coconut oil was recently reported by Villarino et al (2007): only VCO has slightly detectible acid (rancid) aroma, sweet, salty taste and perceptible nutty aroma and flavor. Only heated VCO had sweet taste terms of cocojam or *latik*, but unheated samples have rancid attribute. The fragrance of coconut is attributed to γ-nonanoic lactone (Bunce and Reeves, 1990). Studies by Dayrit et al (2007) and Saavedra (2006) revealed the higher level of volatiles in VCO (0.12-0.20%) than in RBD coconut oil (0.05%). The Reichert-Meissl number (ml of 0.1N KOH to neutralize soluble volatile fatty acids in 5 g fat) is taken as a measure of C4 to C8

fatty acids in oils and is 6-8.5 for RBD coconut oil (Codex Alimentarius, 2005). VCO active components eventually need to be provided for in standard to achieve consumer protection. They need to be defined, not only for authentication, but also for the purpose of health claims, whether direct or otherwise. Examples of indirect claims for coconut oils are: "Research show that coconut oil contains MCTs, fats that provide energy but do not accumulate or deposit in the body tissue as cholesterol." and "Rich in MCTs which may promote easy digestion and rapid metabolism."

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Reactions from Panelists 1

1

Mr. Sammy R. Latay

Chairman, VCO Philippines, Pasay City, Philippines

It's a great honor and privilege to be invited and respond to the presentations made by the excellent minds from the government, the academe and the medical community

I am responding from the perspective of a VCO-industry player or a stakeholder. The question to ask is "What is the significance of these combined efforts of the government and the academe to improve production technologies, to improve quality and discover the new medical applications for our VCO?"

For the past 3 years, we (VCO Philippines) have been trying to do our part to develop this VCO industry. We experienced the birth pains, we tried different production technologies, different packaging and all types of marketing techniques to attract the consumers' attention. We started producing VCO using traditional fermentation technologies or the traditional *latik* and moved on to the more advanced centrifuge and vacuum drying, which are widely used for food processing.

We were able to market and sell VCO products on the basis of testimonials and folkloric accounts of the benefits of VCO. Good that we have the first ever HIV/AIDS clinical trials of our very own Dr. Conrado Dayrit, which we always mention in our marketing materials, internet and reference books. It was also a blessing that some Americans like Dr. Bruce Fife and Bryan Shelhavy of Tropical Traditions believe in our coconuts and helped in popularizing them in the US, one of the biggest VCO markets.

We are glad that we decided to bond ourselves and put up a non-profit association to initiate the advocacy for the use of VCO. We are glad that we were able to quickly develop and adopt the Philippine National Standards for VCO, the first one in the world.

We hope we could do more but there are a lot of obstacles we encountered along the way. And foremost among the obstacles is how to source the funding required to finance the activities and operations of the association.

Now we are very happy that the association has partners to address the quality and health aspects of the VCO. This will definitely help us grow

and nurture this young industry.

From among the many items in our wish list to help the industry grow, I focused on four significant ones. Significant because achieving them would definitely increase demand from the numerous applications generated for our VCO. As a marketing person, the four wishes are:

1. Published and peer reviewed internationally
   - No *trans* fats, saturated fats MCT
   - Clinical trials: heart, HIV, etc.
2. Take out from VCO Label – "No Approved Therapeutic Claims"
3. Medical doctors to prescribe VCO to patients
4. R&D: Develop new platforms for new markets

When do we expect the fairy godmother of VCO to grant us our wish?

I would like to translate the items in the wish list to two very important activities:

1. What would be needed to educate the opinion makers? Opinion makers make or break a product, and in our case an industry. I would include in the opinion makers the following: food formulators, nutritionists, writers, researchers, publishers, medical doctors (who prescribe), law makers.
2. Product development. Right now, most of us producers and traders are looking at VCO as a food supplement. But we need to reach our consumers and find out their needs, their requirements so that they will continuously use and benefit from VCO.

What discourages consumers is the form by which to take VCO – liquid. A number of alternatives forms are now available in the market like soft/hard capsules, flavored VCOs, etc.

We should aim to bring VCO beyond the supplement arena into other areas like food, beverages, cosmetics and pharmaceuticals.

I culled, from among the many reference materials I have, some specific cases. which I could use to illustrate what needs to be done beyond the technical aspects of production, quality assurance and clinical trials.

I chanced upon a very appropriate issue of Functional Foods and Nutraceuticals (July 2005) which featured:

- *Trans*-fat free formulations, and
- News analysis & perspectives for new markets and platforms for *omega-3*s.

Let's start with *trans* fat free formulations.

We all know that VCO and unhydrogenated coconut oil do not contain *trans* fatty acids. So when US made it mandatory to include in the label

trans fats starting January 2006, we all jumped with joy for anticipation of big business.

The positive questions everyone asked was "Can we supply the requirements of USA?" or the world for that matter.

Historically, bakers relied on natural animal fats to impart many functional and flavorful attributes in bakery foods. Then, animal fats lacked consistency, and cholesterol became a hot-button issue.

Animal fats were replaced by tropical oils (coconut and palm) but were maligned due to high levels of saturated fats. The third attempt was partially hydrogenated vegetable oils – inexpensive, easy to manage and can be customized to fit any baking needs. Hydrogenated vegetable oils revolutionized the entire baking industry. Then came the *trans*-fatty acids, which have negative health implications.

In looking for the right fat solutions, tropical oils lost to other alternatives.

Why? Because all the existing literature (books, magazines, websites) in the US used as reference by the opinion makers, like nutritionists, formulators, editorial writers, medical doctors, etc. contain information that coconut oil contains high levels of saturated fats which is bad for health. Up to now, this is not yet corrected. And we need to address this fast!

So what happened? US researchers and food companies developed new products from their existing oil crops. They implemented blending to achieve desired fatty acid levels, GMO and other technologies to address the issues

What about the area of R&D? The *Omega-3* Story. I got interested in the article because there are parallels between VCO and fish oils (*omega-3*) in terms of market development.

So what is *omega-3* good for?

- *Omega-3* fatty acids claims said to bolster
  - The heart
  - The brain
  - The mood (antidepressant) and
  - The skin
- Benefitting patients of
  - Breast cancer and
  - Alzheimer's disease

Many articles and books were written about the health benefits of *omega 3* and a lot of *omega 3* product supplements came out in the market place like liquid, capsule, etc. Do you remember the taste of cod liver oil our mothers gave us when we were children? I hated the taste despite the knowledge and assurance that the oil is good for my health. What factors really helped increase the demand for *omega-3*? According to NuMega, a UK-Division based supplements company, the three factors which helped *omega-3* are the following:

- Technology – Ingredient and formulation side
- Science-backed health benefits and
- Consumer interest, education and demand

Researchers found a way to put *omega 3* in powder form.

- Powder form
  – As an oil, very limited application
  – As a powder, it can be utilized in many varying dosage forms including most functional foods.
- Allows more manufacturers to use as an ingredient for food products

And a lot of new applications came out. Examples:

- Gourmet bread containing linseed-sourced *omega-3*s in France.
- A cereal-and-fruit bar enriched with *omega 3* DHA called BRAINSTORM!
- Sliced pork products with *omega 3* in Portugal
- Nestle's strawberry flavored dairy drink for kids fortified with *omega-3* fatty acids.
- Eggs laid by hens fed with *omega-3* feed formulation
- Multi-grain pasta fortified with *omega-3*.

I bet over a hundred more were included in the list during the last 18 months.

To summarize:

The big leap from supplements to new platform would require:

- New improved formulation technologies
- Government-backed health claims
- Friendly press eager to convey a seemingly endless stream of positive research

Definitely, VCO producers and traders could not do this alone!

What we are doing now at DOST and Dept. of Health are very, very important. However, we also need to have them published internationally, reviewed by peers, presented in international conventions, standards developed by recognized organizations (CODEX – FAO / WHO), etc. in order to realize full impact in the market place.

But then, the ultimate challenge for the Association and the government is *"How do we bring the benefits down to the coconut farmers' level?"*

Thank you and have a good day!

2

Dr. Ricardo R. Del Rosario

Retired Professor of Food Chemistry
Institute of Food Science and Technology, University of the Philippines Los Baños, Los Baños, Laguna, Philippines

I wish to commend Mr. Carlos Carpio for his very comprehensive and enlightening paper. This is probably the most comprehensive collection of processes for the production of VCO. This paper would be an excellent material for anybody thinking of going into VCO production.

In advance countries, industry people do not openly discuss processes for products already in the market. If asked about the process, they just answer either they don't know or it's confidential. Here in the Philippines, people openly discuss processes for important products in the market. This happened in *nata de coco* where foreigners are entertained inside the production area and shown how it is done. Research institutions try to outdo each other by coming out with press releases about production and processing.

Two general processes were described, the dry and wet process. The dry process involves grinding the coconut meat, drying it at low temperature and extracting mechanically the oil.

The wet process should be examined carefully because of probable conflict with the VCO standard. If you look at the wet processes, there is no step to control microbial contamination in the extraction of coconut milk. Studies at UPLB showed that coconut milk extracted using the traditional method is grossly contaminated. For bacteria alone, there were 10 different genera isolated. Coliform organisms are common. Most of these contaminants are from the husk and shell that came in contact with the soil in the coconut farm, where animals usually roam. Since the incubation process takes a long time, these different organisms could elaborate metabolites that are foreign to VCO.

Mr. Carpio mentioned institutional efforts and action program for the emerging VCO industry. These activities should be directed towards 1) implementation of good manufacturing practices (GMP) and quality assurance in the industry, 2) R&D program to verify health effect of VCO, 3) enforcement of viable VCO standard , 4) stop people from discrediting each other's product in desire to increase their market share and 5) continue R & D on VCO.

The excellent paper of the younger Dr Dayrit showed the expertise and care applied in the analysis of VCO. The fatty acid analysis was done

using a method that monitors both efficiency of preparation and extraction of methyl esters and recovery in GC.

The *trans* fatty acid data are excellent and should help lay down the issue of *trans* fatty acid in VCO. If there are projects on this subject in the future, it should be given to Dr. Dayrit.

The Karl Fisher method proposed for moisture determination is alright, however, if you look at the cross section of the VCO industry and its capabilities, other simple and less costly alternative methods should be proposed. Addition of sand or glass beads to the VCO should accelerate the removal of volatiles at 105°C.

The paper of Dr. Connie Lizada covers many papers on the health effect of coconut oil and medium chain triglycerides. What is needed now is to collate all these literature, evaluate the results and come up with a publication that will hopefully counteract the bad image of coconut oil.

Open Forum 1

Acd. Jose O. Juliano, PhD

President, Calamba Medical Center and former General Production Manager, Unilever Research Laboratory, Unilever NV, Vlaardingen, Netherlands, Moderator

Acd J JULIANO: Good morning, everybody. We had a lively session this morning and we will try to end this open forum livelier. Before I will start the open forum I hope you will allow me a few minutes to give my comments. When I came to this meeting, I said to myself, "Can you tell the difference between a virgin oil from a non-virgin oil?" I am glad to hear that from the younger Dr Dayrit, that he can now tell the difference by looking at the minute part of the oil that is volatile. And of course, Dr. del Rosario says that it is very difficult to do that because it might easily break down. From my point of view, I am still worried because if I want to sell VCO and make a killing, I can still add 80% or more RBD CNO and sell it as VCO. And nobody can tell me that I am adulterating, even the Bureau of Food and Drugs (BFAD) will not be able to prove that my product is not VCO. This is bad because you can sell something cheap, which your competitors are not going to do. I am talking about people who are not here today and who make VCO. Because of the sensitivity of the test of Dr. Dayrit; I am also wondering what will happen if you add flavor to VCO. Can the chemist still see the difference between VCO and RBD CNO? Will it still be VCO or does it become "raped" virgin coconut oil? When you add other ingredients like colorants, vitamins, minerals, etc. can we still say whether it is VCO? So unless we know what is the difference between the two kinds of oil, we are treading on very dangerous ground.

The other aspect I would like to comment on is packaging. The packaging should not be just beautiful but it should also protect the product. Our packaging should protect VCO. Is it possible that the VCO you package now, will not be a VCO one year later? Your VCO may not be a virgin anymore, because it has transformed to ordinary coconut oil? I don't know, because your present standard cannot tell the difference between VCO and RBD CNO. Your processing standard may be correct but how do you tell whether he followed the correct processing standard or not by analyzing the oil?

Just recently somebody gave me a bottle of VCO but when I opened it; it stinks because of the free fatty acids present. We don't want free fatty acids in the product. If you have high moisture, you will create high free fatty acids; so you must reduce the moisture.

And my last comment is with the use of biodiesel in cars, there will be more demand for coconut oil. There will be a supply problem because we will be going to use coconut oil for food, coconut oil for curing and coconut oil for diesel fuel. So we have to plant more coconut trees. If there's big demand, coconut oil prices will go up.

For the open forum, will you please mention your name and maybe the person you want to answer your question. We have only three panelists, anyway you can ask anybody I suppose. The table is now open for the open forum.

Mr Gilbert EVARISTO (President, GEMA Coco Foods Corp): Hi, good morning. I'm Gilbert Evaristo, President of Gema Coco Foods, the major exporter of coconut products, number one in virgin coconut oil, also coconut cream and water. I have three questions. To Dr. Dayrit and Dr. Lizada, our business is mostly with the US and we want to ship to other countries but the other countries are demanding. Their ministries of health demand what is really good about CVO and data to back up the claims. So the question is this, the data that you presented today on the health benefits, do you think these are strong enough at this stage to be used as technical basis to validate the claims so that the product has something to stand on, rather than just anecdotal evidence?

Dr. C LIZADA: This is reminiscent of a paper I presented recently on ethical, legal and social issues (ELSI) regarding the standard for health claims. In fact, I'm sorry, I was not able to emphasize it more strongly; you can actually come up with direct and indirect claims. The direct claims are much, much more difficult and more restrictive in terms of whether you will be permitted to do that or not. But for the indirect claims, I always cite the example of the box of prunes. Prunes have not been approved for a direct claim but when you look at the four panels of the box of prunes and keep on saying this is high in fiber and fiber has been found to ... And that is the way around, we are saying science proceeds that way anyway. You know you progress and you say you progress with this; unless you have evidence to the contrary then you assume that it is applicable. But the way you word it is very critical. In fact, when you look at the two examples from RBD CNO that I put up, these are indirect claims. They are saying that VCO contains MCT, which has been shown to...., that is allowed.

Mr G EVARISTO: Okay, are you willing to put that in writing so that we can quote you. You are going to be put to the test sometime, you know. There are people who are putting good money to back it up. In fact what happens is that some of my clients have taken on the burden of advertising in their respective countries and they are using technical claims that we

have gathered here. We are really on thin ice because some of those claims have disclaimers so we talk on very general terms. We can't talk about HIV, for example, as its most exciting health benefit, if it can not really be validated. Can VCO really stop weight gain, especially in the very developed countries? That is the big thing! The no cholesterol claim, that's given and they accept that. The improved metabolism seems to be a fact, but so what? It has to be followed up. It begs a question. So it improves metabolism therefore it can get all the nutrients of what you eat, therefore you become healthy and it provides you this wall of protection against bacteria, fungus, HIV. It would be great if we could say that and back it up! Because ultimately, that's what the industry needs.

Another question here, I think, is that are you claiming it for VCO or for coconut oil? The underlying assumption obviously is that cooking oil, which is RBD CNO, will not give the same benefits as VCO. Another question that I am begging an answer to is what is it in the VCO (in very, very specific term) that makes these claims possible?

PARTICIPANT A: Maybe the committee on virgin coconut oil should come out with a written statement that can help the industry.

Mr. G EVARISTO: It is better if the statement comes from an authoritative group. And we can cite it. Otherwise any company that sells virgin oil would come up with its own claim which could be misleading, or erroneous. I guess, this is what people are expecting from this activity; why we are all here.

Acd B JULIANO: The National Committee on Coconut Oil Research for Health actually came out with a position paper with references. And it is in the appendix to the 2004 NAST VCO roundtable discussion proceedings distributed today. You may want to refer to this paper prepared by all the experts present, especially the Clinical Sub-committee headed by Dr. Jaime Galvez Tan. Dr. Dayrit was one of the principal contributors to the position paper. We tried to look for claims that are substantiated by articles by Western scientists in Western publications. But these are claims not only for virgin coconut oil, because the earlier work was really done on coconut oil. And as far as we know, we still don't have solid clinical evidence to show that virgin coconut oil is really better, health wise, than RBD cooking oil, although it is more attractive to consume directly. Because people still consider RBD CNO as a cooking oil, although it is edible. Unfortunately, clinical studies to date have used only one coconut oil: RBD coconut oil, heat-processed VCO or cold-process VCO. Thank you.

Acd J JULIANO: I suggest that you stay for the afternoon session and

listen to the presentation on health studies on VCO. Maybe we have two more questions before we run out of time.

Ms Estrella GALLARDO (Prime Newsweek): Good morning. My question is, VCO can be processed by cold process or heat process. Is the food supplement value the same in heat process and cold process?

Acd J JULIANO: Who would like to answer that question, please? The producers are here, so probably you can answer the question. For cold, Sammy and Jun. For heat ...

Dr. F DAYRIT: I think we are in the process of finalizing some data that we can tell apart, cold and heat process. But which is better, we cannot answer because that would be the effect. Or it could be on the shelf life, and we are not doing the shelf life study. But to the question, can we differentiate them, yes we can, but we are not using the standard tests. We have to use the more sophisticated process, the more sophisticated your question the more sophisticated your techniques. So using the more sophisticated techniques can differentiate cold process from the heated. But the second part of your question, which is better? I am not in the position to answer it.

Ms. E GALLARDO: May I add something. Because according to Dr. Conrado Dayrit's book about coconut, I asked him very particularly about: are they the same? And he said, "yes"! Because coconut oil and VCO are saturated fats, which are stable and have the same fatty acid composition. He said that saturated fat is stable to heat, like the lauric acid in coconut oil. And he told me that the one we used to make *latik*, its oil is the same as that from the cold process. Maybe we should ask Dr. Dayrit.

Dr. F DAYRIT: My quick answer to that depends on your criterion. We compare things using many criteria. So of course when you heat something, volatiles are lost, so differences may result. So the question is, what criteria are used to say something are the same and some have difference. I think that is the problem. But certainly, Dr C. Dayrit is correct, there is no change on fatty acid profile.

Mr Oscar G GARIN (PCA Administrator): Sorry, I am not a participant in this symposium and I have not paid my fees required here. But I am just surprised to hear, are they the same? Are the heated and *latik* VCO and cold process VCO the same? Can we be clarified? We want clarification.

Acd Conrado DAYRIT (VCO expert): The fatty acid composition of

the two products is the same. So that if the medical aspects, medical health claims are due to the fatty acid or the monoglycerides, they probably would be the same. Our studies on HIV/AIDS was done with Minola, there was no VCO at that time. But the taste is different, the amount you can take by mouth is different. If you want to take *latik*, you cannot take too much of it because it is very sweet and it has many ingredients. So that the product that you want, the VCO, should not be colored too. Usually it is white or colorless. Usually it has no strong taste, usually it is more liquid that copra oil and it is easier to swallow; easier to take five tablespoons. Nobody has ever taken cooking oil by tablespoon. Those physical processes can modify the use of the products. But as far as health benefits, if you take the same amount of fatty acid the effect should be approximately the same. That is the point that we raised. Because as I said, we did our studies on HIV AIDS with Minola RBD CNO and cured 60% of 14 patients treated.

Acd J JULIANO: I was allowed to have three more questions and after that we will close but I see four. Alright, just those who raised their hands and that is it.

Mr Paulo P MAMANGUN (Coconut Haven Philippines, Inc): *Maganda umaga po.* I would like to take the cudgels for the industry now by proposing a request which I have been doing now for the past three years in different fora. First, the Philippines is probably one of the country which does not have a dietary policy but there is a global dietary policy that we are talking about, correct me if I'm wrong. Dr. Dayrit, do we have a global dietary policy, which practically binds the use of coconut oil in the diet of the respective countries. Here in the Philippines, we do not have a nutritional dietary policy that explains that even if coconut oil is saturated fat, it is good for the body. We do not have this! Why don't we come up with one, I do not know how this is done, probably with the help of Department of Health or FNRI? Why don't we come up with a national dietary policy of the Philippines, which promotes the use of coconut oil despite its being saturated.

Second, I do not agree that the VCO by cold process and by *latik* (heat) are the same. One can produce *latik* from coconut that are 10 mo or 11 mo old. But with the cold process, one cannot extract oil if the coconuts are less than 12 mo old. Therefore, as the coconut matures, the fatty acid content increases. That means that as the coconut matures, lauric acid content increases. So, in conclusion, I cannot agree that *latik* oil is VCO unless it comes from mature nuts, 12-13 mo old. I cannot agree that the latik oil is the same as cold process oil. Thank you.

Acd J JULIANO: Who wants to answer the question? Dr. Dayrit?

Dr. Rodolfo FLORENTINO (Nutrition Foundation of the Philippines): It is true indeed that we do not have national dietary guidelines on this aspect. Of course we have dietary guidelines for other aspects of nutrition particularly on malnutrition and so on. But not on this particular aspect. The only thing we have is the position paper that was mentioned by Dr. B Juliano that is included in the monograph here. That's the position paper that actually supports the idea that coconut oil is not harmful to one's health. However, there could probably be a way of making this official or as part of the dietary guidelines for the Filipinos.

Acd J JULIANO: Do you want to answer the other part of the questions, Dr. Dayrit? How about the differences about the two processes?

Dr. C LIZADA: I just like to take note of the fact that when you have a process control, you really have to define what you need to do at every step, define the age of the nuts, define the time interval between harvesting, extracting and processing. I see your points that in fact, the difference there, there is a greater probability of fraudulent practices coming in; in the case of *latik* maybe. But if we are to define the process, then the differences will not be there; inherently it should not be there.

Dr. Edmundo LALUSIS (Growrich Manufacturing): Good morning everybody. I am the coco-fuel inventor. I have studied coconut oil and coco-fuel since I was 17 years old. I'm now a surgeon and coco-fuel is still there. We are lucky that there is the VCO and coco-fuel. I want to answer the difference between the cold process and the *latik*. The heated process, not necessarily the *latik* but the heated ones, is similar to the refining process. In the refining process you have to increase the temperature to 200°C, which almost burns the medicinal value of the coconut oil. To produce virgin coconut oil, use a cold process, do not use much heat (less than 60°C) to extract the oil from the meat. It depends on us doctors whether to say the product is good or bad. So for Philippine virgin coconut oil in any form, we do not have any comments on these processes. We support Dr. Dayrit on virgin coconut oil. We are happy that we are now exporting VCO to America in any form. The only thing that we would like to emphasize is that we make sure of its good quality.

Mr. O GARIN: Wait, if VCO and RBD CNO are the same, why do people produce virgin coconut oil? And debate whether it is cold, semi-cold, heated or what, when VCO is the same as cooking oil! Dr. Dayrit used Minola RBD CNO in his earlier studies. So I am sorry for the producers of VCO. This is bad for virgin coconut oil, mark my word! really! It is good

for other stakeholders with different objectives. But if you're really for VCO just like me, I am not a producer but I have benefited from virgin coconut oil which I believed as per statements and write up of Dr. Dayrit, but if they are the same, I am sorry for myself; why did I make the effort to take VCO, when RBD coconut oil had the same effect? It should be clarified. I don't question because I don't understand much. But I need clarification just like the other producers that need clarification. With all the efforts of the producers, is VCO the same as CNO? Please clarify! Because what is endangered is the beholden product, virgin coconut oil, especially the cold process. Please clarify!

Acd J JULIANO: Can we ask Dr. Dayrit to clarify? Please give the final answer.

Acd C DAYRIT: Even among virgin coconut oils, I find patients who prefer certain brands over the others. They differ with the taste, consistency, odor and everything has to be included in the standard in the choice of what is the better VCO. They refuse to take some and will prefer other brands, why? Because the taste, just like when you're taking *adobo* or *pansit*, or whatever you prefer certain cooking. I think that is the important thing there. The Minola, Baguio and all of these RBD CNO have no taste, have no smell and I think the consistency is thicker; nobody wants to take the oil by the tablespoon for any of their ailments. So there is something in the physical nature of the oil that will govern your choice. And for that reason the VCO will still be superior for those who would like to take it in bigger amounts, rather than cooking oil. But we still need the clinical comparison of the various oils to answer Mr Garin's question.

Mr. O GARIN: So the big issue is only the palatability factor. If you lack money to buy VCO, you may swallow ordinary coconut oil quickly and you have the same effect. And that's a case of death of virgin coconut oil.

Acd C DAYRIT: I don't think that would be as drastic.

Acd J JULIANO: I was told that the food is getting cold, we can continue discussion among ourselves. But I would like to close the open forum which I said is livelier because we have still the session this afternoon.

Acd C DAYRIT: I think we have to look into the monoglycerides content of the two. The monoglycerides is the most active component of these medium chain fatty acids. I think that should be part of the study to be done, comparing them among the different processes.

Synthesis 1

Engr. Raul C. Sabularse

Deputy Executive Director, PCIERD, and Chair, DOST Interagency Committee on S&T Program for VCO, Taguig City, Philippines

Let me just go through the presentations that were made this morning. Of course the main objective of this workshop-seminar is to review the current state of VCO production, standard and health claims. This morning we had a presentation about production Let me just point out that in terms of production, we have a growing VCO industry; there are different processes being used; process dictates the price, cold, heat, centrifuge type. And these different processes dictate the price of VCO. It was also surprising for me to know that 93% of our export goes to the US. Our adversary on coconut oil is the main importer of VCO. Let me also cite some of the constraints that were mentioned that still apparently the VCO industry does not go down to the benefit of the farmers. This is still our concern. Although we have now a growing virgin coconut oil industry, the farmers, whether the coconut is for copra or for VCO, gets the same price for these coconut. And we need to have probably a regulation, the scheme for new plants and the pricing system.

And of course the presentation of Dr. F Dayrit is very interesting. He was able to tell us from the scientific point of view that there is a way of distinguishing ordinary CNO from VCO. His basis is scientific. And I think with these results of the research of Dr. Dayrit there are now information data that we can use to revise or improve the existing standard for virgin coconut oil. I hope that happens soon. Because, as reminded by Dr. Fortunato Dela Peña, everytime he sees Cong. Diaz, the latter always asks him "Where is the VCO standard?" And I think Dr. Dayrit's research is a breakthrough. He also talked about other things, if I am not mistaken, the main thing that distinguishes virgin coconut oil is the higher volatiles, and he was able to produce a chart for VCO volatiles in terms of moisture and volatile organic matter.

And then of course Dr. Lizada gave us the rundown of researches being done on virgin coconut oil and it is unfortunate that I didn't take much biochemistry since her presentation was heavy in biochemistry. But if I

may take note of some of the things she mentioned, we really need to collect data for the health claims and we have to identify the active substance from the VCO, the problem of the active substance that make VCO tick versus the ordinary oil and the mechanism behind these health claims. She also discussed to us some of the potential areas for research. She traced for example some of the researches on MCTs versus LCTs, and antimicrobial benefits. I stopped to keep notes after such long terminologies like thermogenesis, so for example one question is: why is the MCFA present in mother's milk; that's a big question that needs to be answered for the benefits of those in virgin coconut oil industry. And of course she touched on what's going on in terms of standards, where she cited the very big work done by Dr. F Dayrit.

From our reactors, we had some wish list from the industry. I repeat it again, to answer the therapeutic claims, publish the findings from the scientific community in international journals to become basis for their advertisement or labeling. Then, of course, also to develop new platform for new products. They wish that we can educate opinion makers such as nutritionists, product development companies and even the legislators on the benefits of virgin coconut oil. He gave an example of the development of *omega-3* as a parallel approach of promoting VCO. Now *omega-3* is widely used even in some food formulation. They hope that VCO can take the same development in terms of the wider utilization and promotion. And of course, Dr. del Rosario pointed out some improvements that need to be made in terms of the standards. Keep it close and yet open to allow new products for development. And of course, he particularly noted the points that we have to look at, microbial contamination issues prior to the production of VCO. We have to know the source of our coconuts. And then of course, the lengthy, beautiful discussion. I think I may conclude that the question to use or not to use virgin coconut oil is still unresolved and this afternoon I think there will be more information to tell us more how the virgin coconut oil really benefits, in terms of health claims. Let me just say at this point, that this morning session we were able to conclude that VCO is different from RBD or ordinary coconut oil. There is a way of distinguishing VCO from non-VCO. And there are researches done not only in the Philippines but also in other countries that point on the benefits of the VCO; standards have to be revised or improved to address some of the issues raised by our partners from the industry.

So with that, thank you very much for your time.

4

Health Effects of VCO on Cardiovascular Diseases

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Coconuts, locally known as *buko* or *niyog* has been given the title "Tree of Life" for being most useful, being able to provide everything needed to sustain life. Besides drink, food and shade, *niyog* [coconut] offers the possibilities of housing, thatching, hats, baskets, furniture, mats, cordage, clothing, charcoal, brooms, fans, ornaments, musical instruments, shampoo, containers, implements and oil for fuel, light, ointments, soap and more.

Coconut oil is a saturated fat predominantly composed of medium-chain fatty acids (C8 to C12), 50% of which is lauric acid (C12). Many of the claimed beneficial effects of coconut oil have been attributed to this high concentration of lauric acid. Medium chain fatty acids undergo a different pathway in its metabolism. Unlike long chain fatty acids ($\geq$ C14), medium chain fatty acids are absorbed directly into the portal circulation for oxidation. It has been theorized that this pathway leads to an increase in energy expenditure and a decrease in the deposition of MCT in the adipose tissue. This needs no further elaboration as it has been well discussed by the speakers this morning.

Virgin coconut oil (VCO) is defined by the Philippine National Standards as the oil expressed from fresh, mature kernel of the coconut through natural or mechanical means, with or without the use of heat, without undergoing chemical refining, bleaching, or deodorizing, and which does not lead to the alteration of the nature of the oil (VCO Philippines, 2005). Specific composition and quality factors have also been discussed earlier. It is enjoying tremendous popularity as a health supplement since its introduction commercially a few years ago. The local VCO producers are hoping that it can regain the market dominance that coconut oil enjoyed in the 1960s. Many reference materials on coconut oil abound but very few are specifically on VCO. Locally, Dr. Conrado Dayrit's (2005) "The Truth About Coconut Oil" and Dr. Vermen Verallo-Rowell's (2005) "Rx: Coconuts

(The Perfect Health Nut)" are recommended readings in addition to foreign books such as Bruce Fife's (2004) latest edition on "The Coconut Oil Miracle" and the usual international view presented by Rosemary Stanton's (2002) "Good Fats, Bad Fats".

VCO is touted to be healthful in many clinical conditions practically covering all systems in the body. Fife (2004) lists 2 pages of potential health benefits of VCO, ranging from preventing heart disease, high blood pressure, atherosclerosis, stroke, diabetes, promoting weight loss, killing fungi and yeast in addition to viruses that cause mononucleosis, influenza, hepatitis C, measles and herpes as well as human immunodeficiency virus (HIV); relieving gastrointestinal symptoms of gallbladder disease, Crohn's disease, ulcerative colitis, stomach ulcers and even expelling tapeworms and other parasites; to even controlling dandruff.

For this lecture, I have been requested to deal specifically on the health effects of VCO on the cardiovascular system. To refresh ourselves, the controversy on coconut oil and heart disease started with the article by Ancel Keys (1970) that correlated the intake of dietary saturated fats with coronary heart disease (CHD) mortality from many countries. Since coconut oil is a saturated fat, it is therefore considered harmful. The coconut advocates countered that although coconut oil is saturated, it is a medium chain fatty acid with a totally different metabolic pathway compared to long chain fatty acids and Keys' data came mainly from dietary animal fats while coconut oil is a plant product. Subsequently, the Framingham data showed positive correlation between serum cholesterol level and CHD events (Castelli, 1984). Recently, the worldwide InterHeart study showed that an abnormal ratio of atherogenic lipoprotein B to atheroprotective lipoprotein A is the most common of nine universal risk factors identified in subjects admitted for acute coronary syndrome (Yusuf et al, 2004). The "cholesterol-heart" theory is strongly supported by the beneficial results of statin therapy from many landmark statin trials in both secondary and primary prevention (Pedersen et al, 1994; Shepherd et al, 1995; Sacks et al, 1996; LIPID, 1998).

To review the coconut oil/VCO data on the cardiovascular system, I propose two ways: first is to review the effect of the oil on lipid parameters looking at population with high coconut intake, effect on healthy individuals and feeding trials; and second is to review data of the oil on atherosclerosis, the main vascular pathology seen in cardiovascular disease, mainly from epidemiologic and association studies.

VCO and lipid parameters

Most articles on coconut oil used the traditional coconut oil (CO) in their study since VCO is really a "new product" but experts in this morning's session feel that studies using coconut oil apply to VCO as well since VCO

through its processing should retain all the original qualities of the traditional coconut oil except for improved presentation. One recent article on animal study however reported the use of VCO on rats with increased high-density lipoprotein cholesterol (HDL-C), reduced low-density lipoprotein cholesterol (LDL-C), triglyceride, very low density lipoproteins (VLDL), and phospholipids, and reduced in-vitro LDL oxidation (Nevin and Rajamohan, 2004). A Sri-Lankan study that replaced their usual high coconut intake with cow's milk and corn oil showed reduction not only in the total cholesterol and LDL-C levels but also in HDL-C level with increase in LDL to HDL ratio, considered to be a risk for atherosclerosis (Mendis et al, 1989). Dela Paz et al (2007) of the UP-PGH reported recently at the Philippine Lipid and Atherosclerosis Society's annual convention the preliminary result of a 6 weeks study of VCO on 29 healthy subjects that showed significant reduction in HDL-C, no change in total cholesterol, triglyceride and LDL-C, and significant increase in fasting glucose, creatinine and platelet count. Sarol et al (2001) in a masteral thesis did a meta-analysis of 10 feeding trials on human lipid profile and concluded that considerable heterogeneity exists among the studies with more reporting a moderate increase in all lipid parameters (total cholesterol, LDL-C, HDL-C and triglyceride) though some reported neutral effects. Another study involving 28 males who took part in a 7 month crossover trial with three 6 weeks dietary intervention wherein 50% of their dietary fats was replaced by coconut oil (CO), soybean oil (SOY), or hydrogenated soybean oil (HSO) showed 0.44 mmol/L higher mean cholesterol level on CO than on HSO and 0.13 mmol/L higher mean HDL-C level on CO than on HSO with no significant change on SOY diet (Norton et al, 2005). It is obvious from these different reports that coconut oil does not have a consistent effect on lipid parameters.

VCO and atherosclerosis

Prior et al (1981) studied the Polynesian Pukapuka and Tokelau populations whose daily fat intake consists primarily of saturated fats from coconut and having mean serum cholesterol levels of 170-176 mg/dL for Pukapukans and 208-216 mg/dL for Tokelauns with no significant heart disease noted. Locally, Drs. Florentino and Aguinaldo (1987) reviewed nutrition data in our country in the 1980s and found that despite Bicol having a high coconut intake as its major source of fat, it had low mortality from cardiovascular disease similar to Visayas and northern Mindanao probably because of lower intake of animal foods and higher intake of fish. Dr. Florentino also analyzed the data from the 2003 National Nutrition and Health Survey (NNHeS) and concluded that region V (Bicol) indeed had the highest per capita intake of coconut at 15 g/day but its prevalence of hypercholesterolemia (e"240 mg/dL), hypertension, stroke and angina was always below the mean value for each parameter in all regions of the

country (Dans and Morales, 2005). A frequently quoted article is Dr. Kintanar's (1988) review article on 107 publications on coconut oil as to whether coconut oil is hypercholesterolemic and/or atherogenic or not. He found 73% of the articles to favor coconut oil as non-hypercholesterolemic and non-atherogenic. Of those that showed coconut to be atherogenic, it was claimed that the coconut oil used was hydrogenated and therefore needed additional linoleic acid to avoid the problem of deficiency of essential fatty acids. The 43 of 69 original papers reviewed were animal studies, while 5 were epidemiologic studies and the remaining 21 were human clinical studies. Of these 21 human studies, a total of 83 subjects were recruited in the 5 studies that disfavored coconut oil while 315 subjects were recruited in the 16 studies that favored coconut oil. These obviously are low numbers that cannot merit a meta-analysis.

A recent publication by Nicholls et al (2006) reported on the effect of polyunsaturated fatty acid (safflower oil) and saturated fatty acid (coconut oil) on endothelial function. HDL collected 6 hr after the coconut oil meal were less effective than fasting HDL in inhibiting expression of intercellular adhesion molecule-1 (ICAM-1) and vascular cell adhesion molecule-1 (VCAM-1), while 6 hr HDL after safflower oil meal had an inhibitory effect greater than its fasting HDL. Greater reduction of forearm blood flow was elicited with the coconut meal compared to the safflower meal, suggesting compromised vascular function.

Based on current internationally accepted guidelines for recommendation of any therapy and level of evidence supporting it (see Boxes 1 and 2) (ACC/AHA, 2001), it is my assessment that use of VCO can at best be a **IIb** recommendation since there is still conflicting evidence regarding its usefulness or efficacy, with **level C** evidence since there is no large randomized study to support its efficacy and current claims are based on experts' opinion. As discussed above, population data are only association studies and do not prove causation. It has to be treated cautiously as we are reminded of the vitamin E controversy. Vitamin E containing food has been associated with health benefits but meta-analysis of large trials showed no mortality benefit and use of higher dose vitamin E at 400 mg or more can even be harmful (Miller et al, 2005).

Conclusion

Available studies on coconut oil showed inconsistent effects on human lipid parameters for us to claim that VCO improves plasma lipids. Association studies based on population data are not enough to say that VCO can prevent cardiovascular disease. We do not have data on VCO's influence on atherosclerosis or the vascular wall. We need to design and conduct more clinical trials if we want VCO to go beyond the food supplement or functional food category.

Box 1. Classes of recommendation (ACC/AHA, 2001).

Class I :	Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
Class II :	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.
	Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.
	Class IIb: Usefulness/efficacy is less well established by evidence/opinion.
Class III:	Conditions for which there is evidence and/or general agreement that the procedure treatment is not useful/ effective and in some cases may be harmful.

Box 2. Level of evidence (ACC/AHA, 2001).

Level of Evidence

- Level of Evidence A: Data derived from multiple randomized clinical trials or meta-analyses.
- Level of Evidence B: Data derived from a single randomized trial, or nonrandomized studies.
- Level of Evidence C: Only consensus opinion of experts, case studies, or standard-of-care.

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Review of Studies on the Dermatological Effects of Topical and Oral Virgin Coconut Oil and Monolaurin from Coconut Oil

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Abstract

Two oils used since ancient times: olive and coconut, have been undergoing closer scrutiny in regard their production and uses. "Virgin" and "Extra Virgin" now apply to both oils, and regulatory standards have been made to define these descriptives. Studies on olive oil, especially as a nutraceutical product are many. Studies on virgin coconut oil (VCO) are much fewer. This, because of the cloud of misunderstanding about VCO being a saturate, and an overall assumption that it is therefore bad for the health.

The author, a dermatologist and dermatopathologist with a keen interest in cosmetic dermatology and research, initiated the very first efficacy and safety studies on the cosmeceutical and nutraceutical uses of VCO in 1998. These clinical studies start at first with topical, then oral use of monolaurin, a derivative of VCO, followed by studies on the topical and oral use of the VCO itself. The timeline on how the author began the

clinical studies, followed through the initial results, pursued further investigations to support these initial results, while comparing results with the more established olive, mineral oils, and alcohol, are well detailed in this article.

In recent years, better and more effective products have been produced by the dermatological, cosmetic and nutrition industry to address the perceived demand of consumers to look better and younger. Cosmetic and nutritional products, with some degree of pharmaceutical activity are now called cosmeceuticals and nutraceuticals. In parallel with, also as a result of this demand, there have been rapidly escalating advances in the technological fields of dermatology, chemistry and cosmetics. Inevitably, inquiries have turned towards examining the efficacy and safety of traditional products from nature.

Folklore and the writings on ancient medical practitioners as well as of later day physicians, ascribe to the coconut the ability to effectively treat and prevent many types of diseases. For the skin, and for hair care, the use of coconut products is also a common cosmetic practice.

Two oils used since ancient times: olive and coconut, have been undergoing closer scrutiny in regard their production and uses. "Virgin" and "Extra Virgin" now apply to both oils, and regulatory standards have been made to define these descriptives. Studies on olive oil, especially as a nutraceutical product are many. Studies on virgin coconut oil (VCO) are much fewer. This, because of the cloud of misunderstanding about VCO being a saturate, and an overall assumption that it is therefore bad for the health.

A search of the medical literature prior to 1998 reveals the absence of modern evidence-based studies on the dermatological uses of coconut oil and its derivatives. That year clinical studies were initiated by the author on monolaurin, the monoglyceride of lauric acid. At 46-50%, lauric acid is the dominant fatty acid in coconut oil. Monolaurin was described and studied for its antiseptic effects in the 1960s by Kabara who holds the patent on the process and the product: Lauricidin®. Subsequently, more studies by other investigators, likewise done mostly in the laboratory, validated these initial findings (Verallo-Rowell, 2005).

The first study in 1998 compared monolaurin (Lauricidin® from Dr J Kabara) and isopropyl alcohol hand gels in a randomized controlled clinical trial (RCT) using a US FDA hand gel protocol on antisepsis. With surprisingly positive results on monolaurin's antiseptic effect, more RCTs followed to examine further properties against varied microorganisms. Several of these studies are published (Abraham et al, 2000; Abraham and

Verallo-Rowell, 2001; Sorra et al, 2004; Dim-Jamora and Verallo-Rowell, 2006; Carpo et al, 2007).

Another RCT on the anti-viral effect of monolaurin, presented as a poster, was pre-selected as a candidate for Certificate of Recognition by the international jury at the scientific poster presentations of the World Congress in October 2007. The poster was among the top 4%: 150 of 3,501 scientific poster presentations given this honor (Chua et al, 2007).

Studies in acne (Harsono and Verallo-Rowell, 2004; Pineda-de los Santos and Verallo-Rowell, 2004), and for antibacterial (Singson and Verallo-Rowell, 2007), antifungal (Pua and Verallo-Rowell, 2007), and antiviral (Carpo and Verallo-Rowell, 2007) effects have been finished, are awaiting submission, or will need more subjects to achieve a greater validity.

For four years, monolaurin, in a continuing product stability study including post-market studies, has been found to successfully preserve a hypoallergenic cosmetic line of products, using no other preservatives, except this emollient ingredient (Verallo-Rowell and Moya, 2007).

All these papers confirm what initially was truly surprising: that on human skin, monolaurin is an antiseptic with broad-spectrum effects. A second surprise was its novel mechanism of action that sets it apart from other currently used antibiotics (Carpo et al, 2007).

Having demonstrated the antiseptic effects of monolaurin in human subjects, the next studies were on the virgin coconut oil (VCO) itself. Its efficacy and safety as a moisturizer compared with mineral oil, a standard, was shown in an RCT (Agero and Verallo-Rowell, 2004). Though the study was small, this has since then been followed by 7 yr of clinical use on numerous patients, for dermatological conditions with dry skin. In atopic dermatitis and psoriasis patients at the author's clinic, the regular application of VCO has repeatedly been found to have immediate moisturizing effects, and over time, to improve quality of life and to lower flare up rates of the primary condition.

To validate and quantify these clinical observations, two prospective double blind RCTs have just been finished: topical VCO versus mineral oil in plaque-type psoriasis (Kusuma et al, 2007), and versus olive oil in atopic dermatitis (Dillague et al, 2007). Both studies show significant improvement with the use of VCO versus the other oils. The latter was pre-selected as the candidate of the Skin and Cancer Foundation, Inc. dermatology residency program for the November 2007 Philippine Dermatological Society Annual Residents' Research Contest.

Zinc oxide is a gold standard treatment for diaper dermatitis (DD) and irritant contact dermatitis (ICD). Last year, a resident's award-winning RCT showed pure VCO better than zinc oxide in the treatment of DD (Martires et al, 2006). Another study with similar results has just been finished using a more elegant preparation of VCO combined with zinc oxide

for DD. This product also has potential use as a barrier to use in other irritant contact dermatitis, or for decubitus and other skin ulcers (Tiosudarmin and Verallo-Rowell, 2007).

Oral VCO in Dr. Dayrit's (2000) study was shown to reduce HIV. Oral VCO also cleared the author's case of Valacyclovir-resistant Herpes gingivo-stomatitis with *Erythema multiforme* vasculitis (Carpo and Verallo-Rowell, 2007). To try to explain these effects of VCO, taken by mouth, in a small pharmacokinetic study, the monolaurin and lauric acid serum values were measured prior to intake of VCO and its control mineral oil. Measurements were repeated 1, 2, 4, and 6 hr after. Up to 6 hr with VCO, 1 hr with the control, a small amount of lauric acid and smaller amounts of monolaurin were detected in the blood (Malabanan-Guiyab and Verallo-Rowell, 2007).

A pilot study has also just been started to determine the nutraceutical and potential systemic antibiotic effect of oral monolaurin in atopic dermatitis (Toledo-Tan et al, 2007).

With these studies, we hope to better understand the use and proper dosing in dermatology, and from there to other indications, of oral VCO and oral monolaurin as nutritional supplements with antiseptic effects. Many more pharmacodynamic and other drug studies need to be done to determine efficacy and safety of monolaurin as an oral / systemic antibiotic. Its potential especially with the increasing incidence of hospital and community acquired methicillin resistant staphylococcal organisms, and resistance of other organisms towards standard antibiotics, is a challenge.

The role of diet in acne and other dermatological conditions have through the years, received scant attention. Increasingly, however, this is changing, because, primarily from the field of nutrition, newer findings, convincingly show the role of diet in disease genesis. With the use of these studies, the author recently presented a proposal for an anti-inflammatory diet for acne. This includes adding 7% plant saturated fatty acids primarily from VCO (Verallo-Rowell, 2007), which is neutral or anti-inflammatory, to help balance the pro-inflammatory effects of the polyunsaturated fatty acids. Several RCT protocols are now being prepared for this anti-inflammatory diet, not just for acne, but also for other inflammatory skin diseases: psoriasis, atopic, and contact dermatitis.

A related dietary study to help prevent the development of early skin cancers in photodamaged skin is awaiting approval from the Philippine governmental research funding agencies (Realubin-Ubalde et al, 2007).

In barely 10 years of studying cosmeceuticals and nutraceuticals, the author has shown the wide applications of VCO and monolaurin in dermatology, and potentially in other medical specialties. Other derivatives, especially the coconut's water promises to have equally impressive results.

Cococeuticals is the author's niche term to now encompass coconut products with evidence-based research-proven effects for treatment and for health.

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6

Virgin Coconut Oil for the Prevention of Sepsis Among Preterm Neonates Weighing <1500g in UP-PGH. A Randomized Controlled Trial

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Abstract

Rationale: Medium chain triglyceride (MCT) oil has been used to augment weight gain among low birth weight infants. However, it is commercially unavailable. Virgin coconut oil (VCO) contains the most concentrated, natural source of MCT and lauric acid which have been documented to possess antibacterial, antiviral, anti-protozoal and anti-fungal properties.

Primary Objective: To determine if neonates weighing ≤1500 g given VCO will have lower sepsis and death rates and better weight gain, length gain and better gain of other growth parameters compared to those not given VCO.

Study Design: Triple-blind, randomized controlled trial

Patients and Methods: Neonates with birth weight ≤ 1500 g, able to tolerate at least 50 mL/kg/day of enteral feedings, were included. After informed consent, subjects were randomized into either the VCO or control group. Both groups received preterm formula or breast milk. VCO was

added at 0.5 mL/oz to the feedings of the treatment group. The outcomes were analyzed by intention to treat. A P-value < 0.05 was considered statistically significant. The difference in duration of intervention, the occurrence of feeding intolerance, sepsis, and death were among those measured.

Results: A total of 202 patients were included in this trial (103 in the treatment group and 99 in the control group) were included. There was no statistical difference in baseline characteristics. Sepsis was lower in the treatment group (14/103 (13.6%) vs. 26/99 (26.3%), P = 0.024). Mortality rates were not different among the treatment groups (13/103 (12.6%) vs. 14/99 (14.1%), P = 0.751). There was better weight gain per day (21.3 ± 9.3 vs. 17.8 ± 7.5 gm/day, P = 0.012), gain in length (4.4 ± 3.3 vs.3.0 ± 2.8,mm/ week, P = 0.005) and gain in mid upper arm circumference (4.8 ± 2.4 vs. 3.6 ± 2.1 mm/week, P = 0.001) in the VCO group compared to control. The duration of intervention was shorter in the treatment group (26.8 ± 21.4 vs. 36.9 ± 29.1 days, P = 0.005). There was also no difference in the occurrence of feeding intolerance.

Conclusion: We conclude that VCO supplementation reduces the risk of sepsis, augments weight gain and reduces the duration of hospital stay among preterm neonates <35 weeks. VCO is recommended as a supplement in preterm neonates.

Keywords: virgin coconut oil, preterm, low birth weight, weight gain, neonatal sepsis

Introduction

Neonatal sepsis continues to be a significant cause of morbidity and mortality particularly among very low birth weight (VLBW) infants. The incidence of neonatal sepsis ranges from 30% in VLBW Infants to 0.4% in preterm neonates (Parravicini et al, 2002). In the US in 1991-1993, a study on VLBW neonates reported that 25% had one or more episodes of blood-culture proven sepsis with an associated mortality of 17% (Stoll et al, 1996). However, Stoll et al (1996) revealed that the annual neonatal mortality associated with sepsis declined by 25% from 50.5 deaths per 100,000 live births in 1979 through 1981 to 38.0 deaths per 100,000 live births in 1992 through 1994 (Makhoul et al, 2002). Similarly in Australia, there has been a decline in the incidence of early-onset group B *Streptococcal* sepsis from 2 per 1,000 live births in 1991 to 1993 to 1.3 in 1995 to 1997 (Isaacs and Royle, 1999).

In developing countries, neonatal sepsis remains to be a major cause of mortality among newborns. In Pakistan, in a consecutive cohort of 292 infants with culture-proven neonatal sepsis, the mortality was 68 (22%)

and was significantly higher among VLBW infants (Bhutta and Yusuf, 1997). In Portugal, out of 42 VLBW infants, 48% had sepsis of whom 13 (27%) died (Costa et al, 1996). Unpublished data from the Philippine General Hospital from 1998–2002 showed that sepsis rates have increased from 18.5% to 31% within the 4 yr period. Case fatality rates for sepsis have likewise shown an increasing trend, from 45% to 59%, in the same period.

Various etiologic organisms have been implicated as responsible for causing neonatal sepsis in different parts of the world. In the US, the vast majority of infection (73%) was caused by gram-positive organisms with coagulase-negative *Staphylococci* accounting for 55% of all infections (Stoll et al, 1996). In Australia, group B *Streptococcus* is responsible for causing the majority of neonatal sepsis cases (Isaacs and Royle, 1999). In Pakistan, the agents most commonly found were *Pseudomonas sp* and *Streptococcus pneumoniae* (Bhutta and Yusuf, 1997) while in Portugal, *Staphylococcus epidermidis* and *Klebsiella pneumoniae* were the predominant organisms (Costa et al, 1996). In the Philippines, the majority of neonatal sepsis cases in the nursery of Philippine General Hospital was due to *Alkaligenes faecalis* and *Klebsiella pneumoniae.*

Despite the advances in diagnostic/therapeutic techniques, appropriate antimicrobial treatment, and aggressive intensive care, mortality rates in neonatal sepsis remain high, particularly among certain subgroups, such as extremely preterm neonates, VLBW neonates and neonates with neutropenia (Bhutta and Yusuf, 1997; Bernstein et al, 2002). Several studies have confirmed that the incidence and mortality in neonatal sepsis are significantly higher among infants weighing less than 1500 g (Bhutta and Yusuf, 1997; Kaushik et al, 1998). Among the factors that contribute to the increased susceptibility of neonates to infection, developmental quantitative and qualitative neutrophil defects have been implicated (Bernstein et al, 2002). It has been established that preterm neonates are susceptible to sepsis because they are unable to mount an effective immune response specifically as a result of immaturity in phagocytic function (Avery et al, 1994). Studies have shown that the preterm is unable to produce an efficient pool of circulating granulocytes even with stimulation. Many studies have addressed this relative immune deficiency in neonates. Studies have been done on the use of intravenous immune globulin, granulocyte transfusions, buffy coat transfusions, and even exchange transfusions in an effort to prevent neonatal sepsis and improve survival as a result of sepsis (Weisman et al, 1993).

Providing optimal nutrition is an important strategy in the prevention and treatment of neonatal sepsis. For the past 5 decades, researchers have recognized that the medium-chain fatty acids (MCFA) were digested differently from other fats, and this has made a great impact in the management of several metabolic health conditions. MCFA are broken

down almost immediately by enzymes in the saliva and gastric juices so that pancreatic fat-digesting enzymes are not even essential in its metabolism. This has important implications in the nutritional management of premature infants as they are able to absorb medium-chain triglycerides (MCT) with relative ease compared to other kinds of fats. A randomized trial on the use of MCT supplemented feeds has resulted in a significant increase in weight gain and a decrease in duration of intervention among preterm infants weighing less than 1500 g (Estrallado, 1999). Despite its effectiveness, MCT oil is not commercially available, making it necessary to explore alternative sources of MCT, such as coconut oil.

A trial on the effect of dietary oil supplements on the weight gain of VLBW infants showed that the mean weight gain was highest in the group which received coconut oil (Vaidya et al, 1992). This lead in weight gain continued in the 3 mo follow-up period. The group supplemented with safflower oil had no significant increase in weight compared to the controls and was associated with steatorrhea (Vaidya et al, 1992).

Coconut oil contains the most concentrated natural source of MCFA available (Fife, 2001). Coconut oil contains mostly MCFA (C8-12), with lauric acid (12-carbon fatty acid) predominating, comprising about 50%. Depending on the coconut variety, the MCFA content of coconut oil ranges from 65 to 72%, making it an excellent source of MCT. There are two available types of coconut oil: (a) the commercial type which passes through the "copra" stage and has to undergo refining, bleaching and deodorization where it is heated at high temperatures, and (b) the "virgin" and "extra virgin" type where the oil is extracted through a cold process, preserving its linoleic acid and vitamin E content (Dayrit, 2006).

Virgin coconut oil (VCO), like other plant oils, is composed of a combination of different types of fatty acids. On the average, it is made up of the following: caprylic, 8.0%; capric, 7.0%; and lauric, 48.0%. All these are medium chain triglycerides, consisting of 8 to 12 carbon atoms. The rest are long-chain fatty acids, containing 14 carbon atoms or more: myristic, 17.0%; palmitic, 9.0%; stearic, 2.0%; palmitoleic, 0.2%; oleic, 6.0%; linoleic, 2.3% (Fife, 2004). Unlike VCO, MCT oil, consists almost entirely of just two kinds of fatty acids; it is 75% caprylic acid and 25% capric acid.

Enig (1999) reported that monolaurin is the antiviral, antibacterial and antiprotozoal monoglyceride used by humans to destroy lipid-coated viruses such as human immunodeficiency virus (HIV), herpes, influenza, cytomegalovirus, various pathogenic bacteria, including *Listeria monocytogenes* and *Helicobacter pylori*, and the protozoan *Giardia lamblia*.

Not only might VCO be beneficial to preterm neonates for its MCT component, but particularly for its high lauric acid content. Several *in vitro* studies conducted by lipid biochemists have already demonstrated the

antibacterial, antifungal, and antiviral properties of lauric acid. Laurate, which is converted to monolaurin in the small intestines, apparently inactivates these microbes by disrupting their cell membrane (Byrnes, 2002).

This study is being conducted to investigate both the ability of VCO to prevent infection while augmenting weight gain.

Research Question

Among low birth weight neonates admitted at the neonatal intensive care unit weighing 1500 g or less, will the addition of virgin coconut oil at 0.5 mL/oz of milk feeding result in a decrease in the occurrence of nosocomial infections compared to neonates without such supplementation?

Objectives

The objective of this investigation was to determine if low birth weight neonates (weighing <1500 g) who were given VCO as a supplement to their breast milk or preterm formula would have lower mortality and sepsis rates compared to neonates without such supplementation.

Specifically, it was done (1) to determine the risk of death and sepsis among infants receiving breast milk or preterm formula supplemented with 0.5 mL VCO per ounce (29.6 mL) of milk (VCO group) compared to infants receiving feeds without VCO supplementation (control group); (2) to determine the difference in weight gain (g/d), length gain (mm/wk), head circumference gain (mm/wk), chest circumference gain (mm/wk), abdominal circumference gain (mm/wk) and gain in mid upper arm circumference gain (mm/wk) among the two treatment groups; (3) to determine if there is a difference in the duration of intervention (days) between the two treatment groups; and (4) to determine if there is a difference in the occurrence of vomiting, diarrhea, abdominal distension and feeding residuals among the two treatment groups.

Patient and methods

This was a double-blind, randomized controlled trial.

All neonates admitted in the Neonatal Intensive Care Unit (ICU) of a tertiary government hospital who fulfilled the following criteria were eligible for inclusion in the study: (1) birth weight $\leq$ 1500 g; (2) able to tolerate at least 50 mL/kg/d of enteral feedings; (3) informed consent from the parent or legal guardian. Infants with any of the following were excluded: (1) presence of major congenital malformations; (2) conditions wherein enteral feeding is contraindicated; and (3) active sepsis.

After getting informed consent, infants were randomly allocated into one of two treatment groups: the VCO group and the control group. Randomization was be done by a person not directly involved in the study. A randomization schedule was generated from a computer software (Ralloc™)(Flannagan, 1986). The software uses an algorithm for block

randomization using a random number of blocks of 2, 4 and 6 assignments. Allocation concealment was ensured with the use of sealed opaque envelopes. The envelopes were arranged consecutively and placed in an allocation box in the neonatal ICU. Assignments were placed in sealed brown envelopes.

The VCO group, or the treatment group, received either 24-cal (101 J) milk formula or breast milk, depending on availability and the parent's preference, with virgin coconut oil added at 0.5 mL/oz of feeding. The control group received 24-cal milk formula or breast milk, depending on availability and the parent's preference, without virgin coconut oil supplementation. Human milk fortifier or MCT oil was added upon the discretion of the service and depending on availability.

Feedings were given primarily by intermittent gavage. Upon reaching the corrected gestational age of 34 wk, neonates were allowed to feed by assisted nipple feeding. The volume of feeds was advanced according to individual tolerance as assessed by the attending physician and until a total fluid intake of 180-190 mL/kg/day was reached. Physicians were not aware of the treatment assignments. Milk feeds were prepared by the nursing attendants on duty who were not directly involved in patient care. Data collection and anthropometric measurements were done by a research assistant who was unaware of treatment assignments. Feeding interventions were continued until the patient was discharged from the neonatal ICU. The addition of oral vitamins and other supplements for the purpose of augmenting weight gain were at the discretion of the service in charge. All of these co-interventions were noted and were accounted for during the analysis of the results.

In this study, ***feeding intolerance*** was defined as the presence of abdominal distension, gastric residual volume more than 20% of the volume of the previous feed, and vomiting. Feeding intolerance was considered significant if the patient had to be placed on NPO (nothing *per orem*). ***Necrotizing enterocolitis (NEC)*** was defined as presence of persistent microscopic or gross blood in stools with signs or symptoms of feeding intolerance and characteristic radiographic findings as defined by Bell's clinical staging for NEC (Sehgal, no date).

Nosocomial infection is defined as a localized or systemic infection that occurs during hospitalization but is not present or incubating upon hospital admission. ***Clinical sepsis*** is defined as the occurrence of the following signs and symptoms: temperature instability (hypo- or hyperthermia); signs of organ hypoperfusion such as hypotension, delayed capillary refill time, decreased urine output or significant metabolic acidosis; apnea and/ or bradycardia; leukocytosis or leukopenia; or thrombocytopenia, with a negative blood culture. ***Bacteriologically confirmed sepsis*** was defined as the occurrence of any of the aforementioned signs and symptoms plus a

recognized pathogen isolated from one or more blood cultures with no other recognized cause of infection. ***Urinary tract infection*** was defined as pure culture of $>10^5$ organisms per ml from a specimen collected by either by a midstream catch of urine or a suprapubic puncture. ***Pneumonia*** was defined as the presence of at least one of the following: apnea, tachypnea, cyanosis, bradycardia, rhonchi, inability to feed plus chest x-ray evidence of new or progressive infiltrates, consolidation, or pleural effusion. ***Meningitis*** was defined as having at least one of the following signs and symptoms with no other recognized cause: fever, hypothermia, apnea, bradycardia, stiff neck, meningeal signs, cranial nerve signs, or irritability in addition to at least one of the following: abnormal cerebrospinal fluid (CSF) findings, positive CSF gram stain or culture, positive blood culture, or positive antigen test of CSF or blood. Meningitis was confirmed by examination of cerebrospinal fluid obtained through lumbar puncture with the following criteria fulfilled: (1) CSF cell count showing more than 32 leukocytes/mm^3 of which more than 60% are neutrophils; (2) CSF glucose < 50% of serum glucose; (3) CSF protein of > 150 mg/dl with or without a positive CSF culture (Bjun et al, 2007).

Weight and other anthropometric measurements was done by a research assistant who was blinded to the intervention. These were done using a standard scale and other measuring devices. Infants were weighed upon entry and then daily until discharge. The scale used was precise up to the nearest 10 g. Crown to heel length, head circumference, chest circumference, abdominal circumference, and mid-upper arm circumference were measured to the nearest centimeter using a plastic tape measure. These measurements were recorded upon entry then weekly thereafter, with the last measurement done on the day of discharge. Data was recorded in a standard data collection sheet. The rate of weight gain (measured in g/d) was calculated by subtracting the entry weight from the discharge weight and dividing the difference by the duration of intervention. The duration of intervention was defined as the number of days from the time the neonate is enrolled into the study up to the time of discharge.

As a secondary outcome, the occurrence of feeding intolerance (gastric residuals, vomiting, abdominal distension) was recorded after every feeding. The occurrence of the primary outcomes: mortality, nosocomial infections such as sepsis, pneumonia, urinary tract infection, meningitis and necrotizing enterocolitis were recorded based on the abovementioned definitions and confirmed by the consultant staff of newborn section of the Philippine General Hospital.

Statistical Analysis and Sample Size Estimation

All primary outcomes were analyzed by intention to treat. Relative risk, relative risk reduction, absolute risk reduction and number needed to treat as well as their 95% confidence intervals were computed.

Anthropometric data, gestational age and duration of intervention are presented as means and standard deviations. Gender, appropriateness for gestational age and other categorical variables are presented as proportions. The chi-square was utilized for categorical variables (feeding intolerance, incidence of infections and deaths). A P-value < 0.05 is considered statistically significant.

The study was designed to test the hypothesis that the use of virgin coconut oil will result in a 50% reduction in the risk for developing sepsis. Based on the unpublished preliminary study of Amante and Mantaring the patients on virgin coconut oil had a 6.7% (1/15) risk of sepsis versus the 38.5% (5/13) risk in the control group. Using the above assumptions, an alpha error of 5% and a beta error of 20%, the sample size required to be able to prove the above hypothesis is 90 per group. A contingent of 10% will be added to allow for power despite drop outs. For this study a total of 100 patients was targeted for inclusion.

Ethical Considerations

This protocol was submitted for ethical review to and approved by the Institutional Review Board of the University of the Philippines College of Medicine.

The parents or legal guardians were asked to sign an informed consent prior to the randomization of their infants to the two study groups. A definition of informed consent is included in the consent form. The purpose of the study, the description of the study procedure, and the possible risks and benefits are included in the consent form. The parents were informed of their right to refuse and withdraw from the trial at any time without any change in the care given to their baby. They were also assured of the privacy and confidentiality of information obtained from their baby as a result of the trial. A copy of the consent form in English or Filipino was presented to the parents/guardians.

Results

A total of 202 patients was recruited into the study: 103 in the VCO group and 99 in the control group. There were no differences in their baseline characteristics (Table 1).

A total of 40 patients developed sepsis; 14/103 (13.6%) in the treatment group compared to 26/99 (26.3%) in the control group ($P = 0.024$). The relative risk of sepsis is 0.52 (95% CI: 0.29, 0.93) in the VCO treated group compared to controls with a number needed to treat (NNT) of 8 (95% CI: 8, 57). There is no difference in the risk of death from any cause in the two treatment groups (Table 2).

For the anthropometric outcomes of this study, patients who either developed sepsis or died were not included in this analysis as these conditions can have a large influence on growth. There is a consistent trend for larger

anthropometric measurements in the VCO supplemented group compared to the control group, with statistically significant differences in measurements for weight gain, gain in length, and gain in mid-upper arm circumference. In addition, the VCO supplemented group had lower duration of intervention compared to the control group. This difference can translate into economic advantages as this will impact on the direct costs of hospitalization (Table 3).

Table 1. Baseline characteristics.

Characteristics	Treatment group $n = 103$	Control group $n = 99$	P - value
Birth weight (g)	1.215.1 ± 220.3	1.238.8 ± 249.0	0.473
Birth lenght (cm)	38.5 ± 3.2	38.9 ± 3.4	0.386
Birth head circumference (cm)	27.3 ± 2.0	27.3 ± 2.2	0.861
Birth chest circumference (cm)	23.3 ± 1.9	23.5 ± 1.9	0.540
Birth abdominal circumference (cm)	21.1 ± 2.1	21.7 ± 2.5	0.093
Gestational age (wk)	32.1 ± 2.1	32.1 ± 3.2	0.909
Male sex (%)	51 (50)	54 (54)	0.474
Small for gestational age (%)	52 (50)	58 (58)	0.248

Table 2. Occurrence of sepsis and mortality (Primary outcomes).

Outcomes	Treatment group $n = 88$	Control group $n = 99$	P - value
Sepsis (%)	14 (13.6)	26 (26.3)	0.024
Mortality (%)	13 (12.6)	14 (14.1)	0.751

Table 3. Secondary outcomes.

Outcomes	Treatment group $n = 88$	Control group $n = 73$	P - value
Weight gain (g/d)	21.3 ± 9.3	17.8 ± 7.5	0.012
Lenght gain (mm/wk)	4.4 ± 3.3	3.0 ± 2.8	0.005
Head circumference gain (mm/wk)	3.2 ± 3.5	2.6 ± 2.8	0.258
Chest circumference gain (mm/wk)	4.4 ± 3.7	3.7 ± 9.8	0.511
Abdominal circumference gain (mm/wk)	8.3 ± 6.5	7.1 ± 7.6	0.256
Mid-upper arm circumference gain (mm/wk)	4.8 ± 2.4	3.6 ± 2.1	0.001
Duration of intervention (d)	26.8 ± 21.4	36.9 ± 29.1	0.005

There is no difference in the occurrence of feeding intolerance (vomiting, feeding residuals or abdominal distention) in the VCO supplemented group compared to the control group. Generally VCO was well tolerated with only 9% of participants having significant feeding intolerance (Table 4).

Table 4. Occurrence of feeding intolerance.

Secondary outcome	Treatment group $n = 88$	Control group $n = 73$	P - value
Feeding intolerance (%)	8 (9.1)	9 (12.3)	0.506
Vomiting (%)	4 (4.5)	6 (8.2)	0.336
Residuals(%)	3 (3.4)	5 (6.8)	0.317
Abdominal distention (%)	2 (2.3)	2 (2.7)	0.850

Discussion

Aside from having a high risk for developing sepsis, preterm and low birth weight neonates are also at risk of nutritional deficiencies including protein wasting. This may further compromise an already immature immune system that may impact on the ability to defend against infections. To address the nutritional demands of preterm infants, MCT have been as a supplement to preterm milk feedings. MCT have been favored over long- chain triglycerides because of their easy absorption, rapid clearance from plasma and their ability to preserve immune function (Liet et al, 1999).

In this study, we used VCO, a cheaper and readily available source of MCT, in lieu of the commercially prepared MCT oil. The study demonstrated that those in the VCO supplemented group, who received 0.5 mL/oz of milk feeding had better weight gain, greater gain in length and gain in mid-upper arm circumference compared to the controls. These results are consistent with previous studies conducted by Vaidya et al (1992) and Singhania et al (1989). The improvement in weight gain may be due to the higher calorie content of VCO, which is about 8.37 kcal (35.1 J)/mL, compared to that of MCT oil at 7.67 kcal (32.1 J)/mL.

Virgin coconut oil's use may not be limited to augmenting weight gain in low birth weight infants alone, but it may play a role in the prevention of neonatal sepsis, as well. This study revealed that more neonates in the control group (23.6%) developed sepsis compared to the treatment group (13.6%). The component thought to be responsible for this effect is lauric acid, a 12-Carbon saturated fatty acid, which comprises almost 50% of VCO. This is the same fatty acid found in breast milk, which gives breast milk it's antiviral and antibacterial properties (Lieberman et al, 2006).

Even before the discovery of lauric acid in breast milk, breast milk and coconut oil were used in Ayurvedic times for the treatment of various maladies (Dayrit, 2005). Several studies have proven breast milk's advantages in decreasing respiratory tract infections by inhibition of *Streptococcus pneumoniae* and *Haemophilus influenza* that it's use as exclusive food for the first 6 mo of life has been advocated by the American Academy of Pediatrics (Andersson et al, 1986; Chantry et al, 2006). An even more recent study showed that a daily threshold amount of at least 50 mL/kg of breast milk through the first 4 wk of life is needed to decrease the rate of sepsis in very low birth weight infants (<1.5 kg)(Furman et al, 2003).

Lauric acid is one of the major components of medium chain triglycerides in breast milk, which make up 45-50% of the total fat in breast milk. Lauric acid is synthesized *de novo* by the mammary glands. Consistent with the protective properties of breast milk from infection, lauric acid, in literature, has demonstrated a broad spectrum of activity against enveloped viruses, Gram-positive bacilli, *Helicobacter pylori, Staphylococcus aureus, Streptococci spp, Listeria monocytogenes, Hemophilus influenzea, Neisseria, Mycoplasma pneumoniae, Chlamydia,* fungi (when given topically), and *Giardia lamblia* based on literature.

Our study showed that VCO was effective in preventing infections from *Klebsiella* and gram positive cocci including Methicillin resistant *Staphylococcus aureus*.

Lauric acid exerts its effect by weakening the lipid coats of viruses and disrupting the cell walls and plasma membranes of bacteria. Although, some theorize that lauric acid may actually augment the immature immunologic response of the neonate, specifically by augmenting Th1 responses, which are downregulated in the neonate, as seen in mice studies (Byun et al, 2007).

Conclusion

The use of VCO as a milk fortifier is effective augmenting weight gain, increasing length and mid upper arm circumference. It is also effective in preventing neonatal sepsis, with little adverse reaction to the gastrointestinal tract.

Recommendation

The use of VCO as human milk fortifier for low birth weight neonates is recommended. Further studies to elucidate its exact mechanism of action, its effect on the neonatal immune system and the ideal dose to be given would be beneficial.

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Reactions from Panelists 2

1

Godofreda V. Dalmacion, MD

Professor of Pharmacology and Clinical Epidemiology, College of Medicine, University of the Philippines Manila

This is a perfect example of a logical sequence of presentation. You will see here that the way they presented the studies in VCO is the way we should undertake herbal research. First you need a good systematic review. I would like to tell you that I would disclose a conflict of interest because I was somehow involved with Dr. Mantaring's study.

In the first study the assumption that cholesterol is related to heart attack or cardiovascular death is something really questionable and I agree with that. Because with age alone you can have increased cholesterol without even taking anything at all. That has been proven by literature. My comment only on the first study is that clearly when we undertake a study on VCO, we should separate what the purpose of the oil is being used for: whether you are going to study it as a dietary supplement causing a health outcome or VCO as a therapeutic intervention. That should be very clear.

We saw signals already based on literature and the signals are still inconclusive. What does it mean? It means we need better literature or we need to establish a good signal. We should not do anymore cross-sectional studies. In terms of cardiovascular outcome, we should go forward to hypothesis testing and we cannot do that if we cannot do the same as Dr. Mantaring's strategy. We knew then that he was doing a study on low birth weight neonates. What we did was through the help of Dr. Galvez Tan who was then the Vice-Chancellor for Research of UP Manila, a meeting was held to which we invited Dr. Conrado Dayrit because he is the expert. A seasoned researcher, Dr. Dayrit clearly saw that we should not be wasting our time on the outcome of birth weight but look at sepsis instead. Because he saw the data. That is the beauty of having a peer review. So that is the second message on the first study. Separate your study. Do hypothesis testing. And then be clear on what outcomes you want to measure whether it is a therapeutic intervention you are using your VCO or you are using it as a dietary supplement.

For the second study, I can understand why Dr. Verallo-Rowell was so enthusiastic and very convinced. But, I think the future of VCO is not

only in dermatology, it is also in pediatrics and infectious disease. This paper is based on an *in vitro* study and is a good take-off point for clinical outcome. But the study had no comparator group in terms of a positive control. With our work on TB we saw that even the solvent has an effect on the TB bacilli. We had isolates of TB and used a solvent that the pharmacist swore to heaven was inert, when in fact it even sterilized the TB *in vitro*. We think perhaps you have to look closer into the comparator as far as the *in vitro* study is concerned. Look at the solvent because the solvent might have a sterilizing effect on the broth. Which we did, we used the broth. We emulsified our VCO because if we used the *in vitro*, the petri dish, it will not penetrate the inoculum. Perhaps that's the reason why you need to have a peer review.

I think you should go the way Dr. Mantaring did. Do a peer review. Consult the Department of Clinical Epidemiology because you just cannot say I use 30 or I use 100. For example in the teratosis thing, you have to find out what is the prevalence of developing an additional lesion if you already have the disease. I think you should put also your money on dermatology because when you do a design on dermatologic study, more often than not, we use a topical preparation and, therefore, the ethical issue would not be as difficult compared to a study with oral administration.

The paper of Dr. Mantaring underwent peer review. We talked of sample size, confounders, effect of breastfeeding, or whether it may also prevent the development of sepsis. So, the moral lesson here was there was good statistical assumption. The sample size was calculated based on what we need. That's why you need to consult the Clinical Epidemiology Unit of UP Manila.

My general comment for herbal research... This is a lesson on how we should go forward; on how we should undertake future researches. First, separate your study. State clearly whether you are looking at VCO as a therapeutic intervention or you are using it as a cooking oil or as part of diet. Second, standardize. Not any of the study can do reproducibility study because VCO is not like a drug. With a drug, you know that this drug came from this company. It was produced in this way with good manufacturing practice. There is none for VCO. You have to tell us what the standard is. You follow certain procedures for manufacturing the VCO or the coconut oil and everybody can do reproducibility study. As of this point we cannot do that because the standard has not been set. Although, it could be set in some way. Third, let us not go separate ways. I think this is a call for integration and collaborative research. Let us not look at our own vested interest alone. Let us look first at the future of the industry because this can help us economically. Thank you very much.

2

Rodolfo F. Florentino, MD, PhD

President, Nutrition Foundation of the Philippines
Scientific Director, International Life Sciences Institute South East Asia Region

Good afternoon, ladies and gentlemen.

I think that after all those excellent presentations by Dr. Sy, Dr. Verallo-Rowell and Dr. Mantaring, we can say that we have progressed however slowly in clarifying some of the more contentious issues about the health benefits of coconut oil and VCO. At least we can say with certainty, from what Dr. Verallo-Rowell explained to us, the usefulness of monolaurin, lauric acid and VCO as antiseptic, antibacterial, antiviral, and anti-fungal agents in dermatology. On the other hand, Dr. Mantaring's study has shown the benefit of VCO in sepsis. I think Dr. Mantaring was able to demonstrate a very good model for other studies to follow in demonstrating the beneficial effects of VCO and coconut oil.

Perhaps the most contentious of all the issues involving health related to coconut oil and VCO is its effect on cardiovascular diseases (CVD). This is where the debate still rages, in spite of the growing evidence on the health effects of coconut oil. Dr. Sy very ably showed to us the conflicting results of studies and the inadequacy of data on coconut oil and CVD. What comes out from Dr. Sy's discussion is the need for well-designed scientific research on the effects of coconut oil and VCO. What we need therefore is a broad, multi-level research agenda— from basic to experimental to epidemiologic, to clinical, and randomized controlled trial, in order to reach the level of scientific evidence that Dr. Sy was looking for, to be able to establish the health benefits of coconut oil and VCO on certain conditions, and their harmlessness to cardiovascular health.

Dr. B. Juliano told us that in 2004, the National Academy of Science and Technology formed a National Committee on Coconut Oil for Health Research headed by himself, which in turn formed a sub-committee headed by myself that was tasked in coming out with a monograph on the epidemiology of cardiovascular disease (CVD) in relation to coconut oil, for the purpose of coming out with a proposed research agenda. This monograph is now being readied for printing.

After a thorough review of the literature, from the composition and metabolism of coconut oil, to the epidemiology of cardiovascular diseases and their risk factors, the subcommittee came out with a proposed research agenda, which I would like to briefly discuss. Perhaps this can be the basis for future work at least for clarifying scientifically, the issues on the effect

of coconut oil and VCO particularly on CVDs.

Let me now go over some of the important parts of this research agenda (Table 1).

Table 1. Proposed Research Agenda on Coconut Oil and VCO (RF Florentino).

- In-depth correlation between coconut oil intake and CVD among Filipinos using the data from the 2003 National Nutrition and Health Survey;
- RCTs on the effect of coconut oil and VCO on blood lipid levels, infectious diseases especially sepsis, HIV and pneumonia; dermatologic conditions, and blood sugar and insulin levels;
- Cross-sectional studies in selected regions with high and low consumption of coconut oil and prevalence of CVD and other diseases.
- Studies on the therapeutic actions and effects of coconut oil and VCO through in-vitro, experimental, observational and human intervention trials on its supposed anti-inflammatory, immune modulation, anti-microbial, and anti-obesity properties;
- Longitudinal epidemiologic studies comparing high and low coconut oil consuming regions in the Philippines;
- Studies on the many purported functional effects (as distinguished from therapeutic effects) through experimental, observational and human intervention trials;
- Metabolic and pathologic studies on the effect of coconut oil on blood vessel intima and other metabolic systems at the different stages of the life span with respect to the formation of fibrous plaques and its progression to malignant plaques;
- Validation of cardiovascular morbidity and mortality data from local health units and hospitals;
- Isotopic studies on the metabolism of coconut oil and VCO; and
- Knowledge, attitudes and practices (KAP) on coconut oil and its uses.

First, the easiest thing to do and perhaps the least expensive anyway, something that we could practically do starting tomorrow, are in-depth correlative studies between coconut oil intake and CVD among Filipinos using the data from the 2003 National Nutrition and Health Survey (NNHeS). For example, we can show the association of coconut oil intake and

hypercholesterolemia, hypertension, diabetes, and other conditions. Of course, as Dr. Sy pointed out, these will merely show associations rather than cause-effect relationships. Nevertheless, such associations will be very useful in showing to us the way to other in-depth researches. In fact, there are still a lot of information that could be derived from analyzing the data from the NNHeS together with the data from the National Nutrition Survey of FNRI. We can look at correlations not only with the risk factors of cardiovascular disease but also with other data like food consumption, socio-economic status, and so on.

Another group of studies that should be undertaken as pointed out by all the speakers are randomized controlled trials (RCTs) .For example, we ought to continue studies on infectious diseases such as sepsis, HIV and pneumonia, as well as other dermatologic conditions. We have also heard some effects of VCO and coconut oil on blood sugar and insulin levels. That is something we can also look into using RCTs.

We can also do cross-sectional studies in selected regions with high and low consumption of coconut oil in relation to the prevalence of CVDs. We have somehow started something like this a few years back looking at Bicol and comparing them with Ilocos, but such studies have not been continued for lack of funds. But, I think it would not be too difficult to do cross-sectional studies like this.

Studies on the therapeutic actions and effects of coconut oil and VCO through *in-vitro*, experimental, observational and finally human intervention trials would be most useful in elucidating the beneficial effects of coconut oil and VCO. There are so many such purported effects we need to look into: anti-inflammatory, anti-bacterial, anti-obesity and even anti-diabetes, etc. All of these will have to be confirmed by clinical studies so that eventually we can make definite conclusions, whether positive or negative.

Another group of studies would be the purported functional effects of coconut oil and VCO as opposed to therapeutic effects. Again, experimental, observational, and human intervention trials would be needed. More basically, we can go into metabolic and pathologic studies on the effect of coconut oil on the blood vessel intima. We know by now that the formation of fibroblast on the arterial wall starts in childhood, progressing slowly to adulthood until it becomes malignant blast. This is something that we can perhaps look into.

There is also the need for the validation of cardiovascular mortality and morbidity data coming from the field. We keep on utilizing prevalence and incidence data as well as mortality and morbidity data gathered from the field. I think we have to validate these data.

Isotopic studies on the metabolism of coconut oil and VCO may also be useful. This will confirm what we have been saying about the difference

in metabolism between coconut oil and other oils. Basic studies like these will confirm what Dr. Verallo started to show on the increased levels of lauric acid and monolaurin in the plasma of subjects who have been given VCO.

Finally, studies on the knowledge, attitude and practices on coconut oil and its uses will help us understand how to promote coconut oil and VCO to the population.

While this proposed research agenda may be expensive, this will be a rewarding investment on our part considering the importance of coconut to our economy, not to mention its importance on the health of our people. This proposed research agenda by the way is estimated to cost PhP 300 million. Perhaps some of the Congressmen could probably contribute bit by bit to this. Perhaps we can look into the Bill Gates Foundation and other sources of funds. In any event, we should have a long-term research agenda to finally clarify many of the issues on VCO and coconut oil.

Open Forum 2

Jaime Z. Galvez Tan, MD

Professor, College of Medicine, University of the Philippines Manila
Moderator

Dr JZ GALVEZ TAN: A warm and pleasant good afternoon to all. I hope you have the full energy, the full caloric requirements that we need this afternoon. Within the few minutes that are available, we hope to get an enthusiastic response from everybody in terms of questions. As you can see, one of the major issues mentioned was funding. Definitely there is a need to invest in health research, particularly on coconut oil. The investment in health research will redound to the bounty of the country. If we can bring back the economy of the country in the 30s, 40s, and 50s, wherein the coconut oil was our major export, probably, we can return to 2010, 2020 and 2030 looking back. But, we need the research. So, we need that PhP 300M but where will it come from? Of course, PCHRD does not have that PhP300M, the Department of Health does not have that PhP 300M. Because we now have PhP 68B deficit in our budget due to uncollected taxes, uncollected custom charges, etc. Until that deficit is wiped out, we have no hope for funding. So, my plea really is to get it either from foreign funding. But since the private sector is here, the private sector should contribute. I'm talking of research fees from every sale of coconut oil and VCO. What about 1% of every sale of coconut oil and VCO? I am just asking for 1% and look at the wonders it could do. I am challenging the private sector here led by Ms. Tess Santos, to find out how that 1% can be collected from the total sales of coconut oil and VCO to fund health research. If we feel this is a diamond mine or gold mine that we have in the Philippines and this can be the best saviors of our country, then let us invest in it.

For this particular afternoon, what I will do is that I will gather first a few questions rather than concentrate on one or two individuals. I really want to squeeze everything out of your VCO juices this afternoon in terms of questions; because this is a very good forum, very good attendance. And we really like to get as many questions although some of these may not be fully answered.

Dr Renato LABADAN (Author, Coconut. The Philippines' Money Tree): I am not a doctor. But I am a user of VCO for 2 ½ years. I almost died two and a half years ago because I was following my doctor's advice to take Aspilet everyday. I am so religious in following doctor's advise because when the doctor tells you what to do, you better do it. That was

when I started writing a book. I saw an opportunity on VCO. I've been taking it at 2 tablespoons a day, one in the morning during breakfast, and in the evening while eating. My psychology here is what was said earlier about the taste. I told my mother when castor oil was still popular: "Mother, I will die if you close my nose to force me to take castor oil". My question is more on the economics. I'm taking it at 30 mL a day, its cost now without mentioning brand, in Mercury Drug is PhP160 per 250 mL. Even with my 20% senior citizen discount, there is 12% VAT. So, at PhP160 per 250 mL, that's PhP 640/L, so 30 mL of VCO is costing me PhP 20/day. Is this correct? The capsule is PhP 7 each: if you take 7 capsules per day, that's PhP 50 a day. So the question is economics and efficacy. Because before there was a question, that the capsule is underdosed. I have to be corrected. What is the capsule made of? You are probably taking in more seaweeds with some nutritional value. So, the question is economics and efficacy.

Dr RL GUIBANI (St. Luke's Medical Center): I have concerns about the industry in the field of coconut. I know that it has a very big potential in terms of business and benefits. My point is... I am a little bit confused because of the organization going on. I do not know who is really on top of this. We talked about the production of the coconut itself, the standardization, because somebody mentioned about the standards. We do not have a standard, we do not have a product. How can we come up with a big potential in this industry without even having a standard when we are thinking of big business and its health benefits. In terms of quality control, for me that's very important. Because I have a friend who is a producer, Mr. Pacheco is a producer of coconut oil in Mindanao. I am very grateful because this is the first time I'm learning about coconut oil. For me this is significant in the sense that I might be helping Filipinos who are in need of cardiovascular disease medicines to help the government replace expensive medicines. I am grateful since I have suggestions, which you might consider later on. For me the clinical trial is important since it is hard to give out these products to patients, particularly cardiovascular patients who will be using these products without any clinical trials. One of my suggestions is, one, because I have read on the draft program, there were several departments and bureaus here. My question is who is really on top of this? Secondly, my suggestion in taking care of the production, in terms of standardization, benefits and quality control. What I have observed is that in all commercial stores there have been several VCO branded products. Have these VCO branded products, passed through quality control? Have they passed through BFAD? Because there has been a proliferation of fly-by-night producers, I am highly suggesting to come up with a regulatory board probably from DOH or BFAD to have a national coconut oil regulatory

board, regulating not only the production, standardization, quality control, and probably even price control. There should be a regulatory board. Because I know this has a big potential, business-wise and health benefits-wise.

Ms Estrella GALLARDO (Prime Newsweek): Good afternoon. The monolaurin content of the coconut oil is the same as the monolaurin found in mother's breastmilk. Is this the reason why breast milk is dropped into the eyes to cure sore eyes? Another question, cooking oil like canola oil and other kinds of oil has been pronounced not good for use since it brings harmful effects to the body. The coconut oil is the only oil that can be reused over and over without harming the human body. Is that correct? That is again from Dr. Dayrit.

Dr JZ GALVEZ TAN: I may even have to call the panelist this morning to respond to Dr. Labadan's question since most of them are directed on the organization and management of the National Committee on Coconut Oil. Can we just have a show of hands of those who want to ask questions? Anyone wants to respond first on economics and benefits?

Dr R SY: Well, economically speaking, I think the industry is in a better position to answer. I think the computations are quite correct from what the selling price is. The problem is what is the equivalent of the capsule? Is this accepted? Because if we follow the Philippine National Standard as stated this morning, capsule is not included. Is a capsule an acceptable preparation as proposed by the industry? You have to tell us also. What is being advertised in the newspaper is that a capsule contains 500 mg of virgin coconut oil. A tablespoon to me is 15 cc, or 15 grams. Does it mean that one person has to ingest 30 capsules for the equivalent of one tablespoon? You have to tell us the equivalence.

Dr G DALMACION: You really cannot do cost effectiveness analysis because effectiveness has not been established. What you just can do is really compare the prices and how you can take it. It is similar to cost minimization. But in cost minimization, you can only do that with generic product, because you know that they are therapeutically equivalent and interchangeable. In this case, we have not established the efficacy and we do not even know if the seven capsules will give the same effect as the tablespoon. So, you cannot talk of cost effectiveness and cost minimization here. You can only talk about cost and how palatable the preparation is for you.

Dr R SY: I want to give a follow-up on that because the same question is being raised for example, in flavored preparation of VCO. Is that

acceptable? Because you are telling us in Philippine National Standard (PNS) it should not be modified. But in the newspaper it is being advertised and I'm sure it passed the regulation. Is this the same or not? If we follow the PNS then, this is not the virgin coconut oil.

Dr JZ GALVEZ TAN: Just to summarize. The answer to that is that it requires a fuller study in terms of cost effectiveness and cost efficacy.

Adm O GARIN (PCA): My problem is that VCO is expensive. Why bother yourself with the capsule? Why don't you take cooking oil. Anyway, it has the same effect.

Dr JZ GALVEZ TAN: My answer also, if you don't mind, is that we need to come out with better and comparable standard. Although a standard was earlier mentioned on the flavored VCO. We do not have a standard on the coconut oil in general. I suppose the Task Force, or the Committee in-charge are already on their way. Before I go to the second question is there anybody from the private sector or the producers who would like to respond to the follow-up question of Dr.Rody Sy? Jody Dalmacion has to declare a generic coconut oil before this can happen. Let us go to the question of Dr. Labadan. Is there an organization and management? Somebody on top of this? Are there benefits, quality control assurance and the need for regulation?

Mr Carlos CARPIO: The Philippine Coconut Authority is in-charge of research and development, regulations, extension and marketing. So, in response to the question, the BFAD is in-charge of standards, together with the Bureau of Agricultural and Fisheries Product Standards (BAFPS). That is where we formulated the PNS. And if new scientific data is called to our attention that requires us to modify, then we can modify the Philippine National Standard. So the standard is a changing standard.

Dr JZ GALVEZ TAN: Mainly he wanted some clarification on the organization and management and standardization of virgin coconut oil.

Mr C CARPIO: The Technical working group on VCO standard has membership from PCA, BFAD, BAFPS, DOST, DTI, NAST and the private sector.

Dr JZ GALVEZ TAN: Of course, the NAST has also formed a group in terms of health research on coconut oil.

Mr C CARPIO: There was another question on VCO mint flavor. I was not around during the last meeting but apparently it was approved already

as long as the label used is "VCO with flavor". BFAD states that VCO should be mentioned first, so that you are still following the standards.

Dr JZ GALVEZ TAN: Is there anybody from BFAD here? Is there anyone from BFAD here just to validate or affirm?

Ms Girlie SARMIENTO: Good afternoon. I am the former Business Development Manager for Organic and Natural Products of the Center for International Trade Expositions and Missions (CITEM) of DTI. Just to give you background on who coordinates everything. Initially way back in 2003 there was this Export Development Council (EDC), a convergence of DTI and DOST. That was where birth of VCO interventions were done. But after the convergence of these agencies, other groups were born after the EDC Technical Working Group. It is now a dilemma who will head the overall integration of all interventions, assistance and all the other things. Considering the fact that even mentioning about the market perspective in this research agenda. That's just to give you a background on why there is VCO right now. If there will be integration of agencies, hopefully, there will be budget to allocate even a small amount just to move the industry. The same way that DTI has provided a little amount to move VCO.

Dr JZ GALVEZ TAN: Just to reiterate on what has been on the floor. The Philippine Coconut Authority (PCA) is on top of all activities. There are subgroups, there are task forces, there are also other national committees in-charge of the different aspects from agricultural standards, production standards, and to clinical research standards.

Dr Rodolfo F FLORENTINO: I think the suggestion of a regulatory board is valid unless PCA is already that body to regulate all of these issues. I think it might be something that can emanate from this symposium.

Dr JZ GALVEZ TAN: I think this morning as you all well know that Mr. Carpio showed in his first slide that there are 280 companies that are accredited by the Philippine Coconut Authority. I hope this is in the website. Even Dr. Labadan can look at the website and find whether the VCO that he will buy off the shelf is part of the 280 accredited companies that are producing quality products of virgin coconut oil. That is part of the public information of the Philippine Coconut Authority. Anybody from the panel who would like to comment on the question on the benefits of quality control knowing that the studies of Dr. Mantaring, Dr. Rody Sy and the others that there are things to be resolved ? Any comment to that Jody on the quality of the results?

Dr G DALMACION: Actually that was our problem when we did the *in vitro* study for TB. Nobody can give us the standard product. What we did was to buy commercial VCO that PCA recommended us to buy. In order to keep us blinded on the VCO brand, we asked the PCHRD to be the monitor of the trial and give us the samples in encoded form. It was a very difficult situation. Like if we are doing a trial for Pfizer, and you are doing it for a certain drug, they give you the drug and certain GNP practices. But, with virgin coconut oil, nobody can tell us how it was prepared, what is the expiration date? How do you store it? How do you transport it? Nobody could tell us.

Dr J MANTARING: I concur with the comments of Dr. Dalmacion. What we actually did was to get our coconut oil from Dr. Dayrit.

Dr JZ GALVEZ TAN: This is just to say that we hope that we could respond to the issues that have been raised. This is where the private sector would really have to come together to respond to the issues that have been raised also by health researchers in terms of the uniformity or standardization of the different types of coconut oil to be use.

Mr C CARPIO: During the TWG meetings, BFAD indicated that that if one has license to operate (LTO) from BFAD and your plant is registered with PCA, BFAD will investigate. They will look for HACCP and GMP. Now, if one already has the license to operate from BFAD, and registered with PCA, our understanding is witnesses should report to BFAD or PCA fly-by-night operators as we are understaffed. We hope they are registered with BFAD and PCA. In my presentation, I have 200 plus producers and traders. But only 41 are BFAD and PCA registered. So the rest, we do not know. We now have a standard. For those who do not have a copy of the standards, we can produce a copy.

Dr C LIZADA: The standardization set-up is really compatible with what is referred to us in the end-product inspection. But the discussion this morning with respect to what is better, whether it is the hot and cold process VCO. The problem is on the consistency and predictability of the quality of the product is something that cannot be addressed by end-point inspection. It is really a matter of identifying the parameters that will now be primed to the quality you will end up in the process. Like I was saying earlier, how long between harvest and extraction? How long between extraction and centrifugation? Those parameters have not been established. This is the reason there is a wide range of product quality. Of course BFAD requires Hazard Analysis and Critical Control Points (HACCP) assessment, but in HACCP the main objective is to prevent microbiological contamination.

We need to set up a similar system that will be now define how to go from step 1, step 2, etc. so that your product quality is predictable. You know for all intents and purposes this could actually have an effect on the component. In fermentation for example, how long will you allow the fermentation to go on to make a difference in terms of how much hydrolysis might take place? I think that's the fundamental issue that we now have to address. Somebody told me it's an industry issue. I think we have to work together on this.

Dr JZ GALVEZ TAN: This will really be a public-private discussion. It is really what we are looking at in this forum is also to serve out other concerns. Before I proceed, there is one more question given by Ms. Estrella Gallardo regarding breast milk plus the quality of cooking oil.

Dr J MANTARING: To answer the question on breast milk. I came across a literature that the amount of lauric acid in breast milk fat may be as high as 20%. But the one in virgin coconut oil is as high as 50%, some have even higher levels of lauric acid in breast milk. It was said that colostrum has a cycle and for 3 weeks lauric acid levels in mature breastmilk is high, then it goes down when the baby is 6 months old. It is very dependent on the mother's nutrition. If the mother has good nutrition, the higher the levels of lauric acid. If the mother is undernourished, then there will be low levels of lauric acid which is probably why augmenting milk with a little bit of virgin coconut oil helped improve the outcome of our patients. Because most of the patients that we included in our study were from the charity ward. Before that, I don't know whether that's the reason why dropping breast milk for sore eyes will cure it. There is no study.

Dr JZ GALVEZ TAN: About the cooking oil? Dr. Florentino, do you have any comments? Ms. Gallardo just wanted validation that in terms of the soya, canola and corn oil, which cannot be reused. But on coconut oil you can still reuse after cooking.

Dr RF FLORENTINO: One advice is to reuse it not more than 3 times for coconut oil.

Dr JZ GALVEZ TAN: For coconut oil you can reuse it up to 3 times but for canola, corn and soya oil, you cannot do that. So, now I would like to ask the next series of questions.

Mr Patrick BELISARIO (VCO Philippines): This is in response about the samples. I am the Executive Director of VCO Philippines. Once we receive a request from research groups or from the academe, we will mobilize our members and we will pre-select who are those complying with

the national standards, with BFAD registration and so on. So, once we receive the request, we collect and then we give it to the requesting body. That's one. We have done this with Ateneo, we have done this with BFAD for an in-house study. We have done this for PCA and UPLB Biotech. We have done this with a lot of hospitals who are doing independent studies. So, do not hesitate to approach us if you need official samples from the association. We can give you the different types of processes and we can appoint some of the members to provide the samples. In our own little way that is our contribution to the emerging industry. On the other note on the organization and management, in 2003 the main concern of the producers, who were then less than 10 when we started with VCOP. Our fist concern was to do advocacy and promotion. That is why we have standards because this was our focus in the first year. Then in 2005, we did the promotion. That's is why we initiated the staging of a lot of promotional work. Like the coming here of Dr. Bruce Fife is not accidental. That was backed up by the private sector. The private sector paid for it, the private sector raised money to bring Dr. Fife several times here in the country. In 2006, last year, we would like to share that in our own little way we supported the researches like again of Dr. Dayrit, etc. So we were sidetracked then our members were complaining that there were not much as promotions now as compared to 2005. DOST was not here. In 2006, we started a discussion with DOST upon the instruction of Malacanan to come up with the research package on the quality and the medical claims and the technical support for the industry and the DOST is not that open now in telling the public that they have come up with a research package. But soon within this semester they will be finalizing all the researches that is in partnership with the private sector. This is what VCO Philippines did. Be assured we can always give you the official samples based on the pre-selection of the criteria we established already.

Dr JZ GALVEZ TAN: Patrick, I hope that you will be able to give your business card to the researchers, particularly from the University of the Philippines. And for the research agenda that the private sector is proposing we really like your comments the one given by Dr. Florentino. I would like to call on the private sector to comment on this. This is also in the website of the NAST. We would like to have a merger of the public and private research agenda. Rather than the private sector has their own agenda and then public sector has their own agenda. We might as well unite ourselves. The little money that we have, let's put it to where it will count.

Dr Manuel M GARCIA (Consultant, FDC): I am a visitor here. Tess Santos invited me to come over. I am a microbiologist and food safety expert. I am based in Canada. But I come here every year. I am consultant

of the Food Development Center (FDC) in order to assist industries to improve the quality and safety of their products so that they can be more competitive. Two years ago I was approached by PCA to help them develop an integrated food safety program. In other words, we are not only looking at the technical aspect, but also in the marketing aspect. I have had enough experience in science so I am very happy to say that there have been progress particularly in the area of antimicrobials. Being in food safety, why don't we use coconut oil for sanitizing our hands instead of alcohol. Sometimes you have a higher count when you wash your hands and sanitize it with alcohol. Besides your hand becomes dehydrated so why not use VCO, it penetrates and dries easily. The thing is, being a scientist and having had a collaboration with the industry of Canada, the turnover is very fast from technology to commercialization. Sitting here and playing my part as industry, I begin to wonder where is the connection? I want to market VCO abroad but it seems that science is lagging much behind. I have done some studies to my experience and I have been promoting VCO for the last 2 years to my friends and to whomever I meet. In fact they call me in Ottawa the VCO king. But I don't sell the VCO that I promoted. So, it doesn't matter what VCO is being sold. But we are not penetrating the Canadian market as much as I should like. What I really want to emphasize here is that we do not want to go where *nata de coco* went. In other words, we have to build into the product the safety and quality before it comes out. In order to do that, we need to have a program which, I am happy to say, that PCA is supporting very well. Knowing the market abroad, I find that the industry would have to depend on themselves to market, because unfortunately DTI does not have enough people to help us market these. So in this way, I would be very happy if we could market VCO faster because there are products there from other Pacific islands. If we don't move fast, we will be overtaken again by our neighboring countries.

Ms Erlinda ERIGO (Provincial Board Member, Davao Oriental): I am here as a public official and I believe that our PCA Administrator Cong. Garin and Mr. Carpio cannot deny that Davao Oriental is the biggest producer of coconut. For the producers of coconut oil, I am inviting you to Davao Oriental where you will find the raw materials for the exportation of your product. Thank you.

Dr. Edmundo LALUSIS: I represent Growrich Manufacturing. We have a problem actually: we want to market VCO in different countries, we have gathered all the necessary information available, but the only problem that we want assistance is to increase the expiration (shelf life) of the product. This is the main problem in exporting coconut oil. Is there a way by which shelf life could be extended?

Ms. Divina BAWALAN (VCO Consultant): I am formerly a Senior Science Research Specialist of the PCA but now I am a consultant on VCO processing of the FAO Office for Asia and the Pacific. This is not actually a question but I would like to comment on the issues raised. First, on the use of VCO for sore eyes, personally I would not use it because we have to remember that the lauric fatty acid in coconut oil is in the form of triglycerides; it is 3 molecules bonded to 1 glycerol molecule. Then according to Prof. Kabara in his statement regarding the antibiotic property of lauric acid, the statement is that when you ingest coconut oil, your body produces the disease-fighting monolaurin which means that it is your body metabolism that breaks the triglycerides into its components.

On the issue of economics and efficacy, my stand is that VCO is more or less another form; it's a coconut derivative form. But I said, that in the Philippines, if you cannot ingest VCO as it is because it is an oil, you can increase consumption of the coconut meat itself or coconut milk in your diet. For example, if you eat rice cake *(puto)*, you can take more grated coconut with it, that way you are also taking in coconut oil and at the same time you have an added advantage of coconut dietary fiber. An FNRI study that we did when I was still with PCA showed that the dietary fiber content of coconut is greater than that of oatmeal.

On the issue of shelf life, I would like to share with you that even when VCO was not yet known in the market, I have tested these different processes. What I found out was that as long as you process it properly and you maintain the moisture content of VCO at 0.1% or below, the shelf life of the oil is extended up to 5 years. We have samples in our Davao research laboratory that were produced in 1998 and 5 years after, these are still very stable, the free fatty acid content has not increased beyond 0.1%.

Dr JZ GALVEZ TAN: Thank you. Before I ask the panelists to respond to the issues, I would like to announce that through the National Committee headed by Dr. Bienvenido Juliano, the DOH agreed to finance the 30-sec TV commercial regarding the virtues of coconut oil. It could have been premiered today but DOH did not have enough time, since it was filmed only two days ago. We hope that it could be aired in another forum. Since airtime is expensive in other stations, the commercial will be aired only in Channels 4 and 13. The industry may want to take up the cost of airtime in Channels 2 and 7. Before I close, I would have wanted to hear from the industry the question on regulation.

Adm O GARIN (PCA): There is money somewhere: the Coconut Industry Investment Fund (CIIF) may be. The science sector should discover the probable sources of funds.

Dr Patricio S FAYLON (PCARRD Executive Director): DOST supports the initiatives for coconut oil: Dr. Montoya for health, Engr. Sabularse for industry and me for agriculture. An issue raised by Dr Connie Lizada, particularly on the coconut variety, *vis-à-vis* VCO are the things that we are doing right now. We have prioritized and actually funded studies on VCO that are ongoing and outputs are still in the pipeline and forthcoming.

Engr Nelson BENIABON (PCASTRD): I would like to tell the body that we at PCASTRD-DOST gave additional funding to Dr Toby Dayrit to enable him to continue his study on VCO in the amount of PhP 2.5 million and DOST is committing another PhP1 million. DOST GIA funds can be tapped for funding VCO studies since this is a priority.

Mr P BELISARIO (VCO Philippines): On Quality Assurance, at first we were thinking of enforcing the standards. Before, we were not quite sure if government or BFAD will pick it up. So we were thinking of a private standards, then it will be done on a voluntary basis, sort of self-regulatory method patterned after the ISO 65. When PCA or the DA adopted the standards, then BFAD said we will enforce it, we will require all producers to register, get their GMP and HACCP LTO. Then the discussion within the association said, let the government do it. Then early last year we did a feasibility study on how to implement an internal Quality Assurance (QA) among our members. Between issues of research – the need to get as many scientific evidence/data than QA, we prioritized helping DOST and other partners who have requested the private sector to participate in the research. So, we already have a feasibility study on how to do quality assurance among our members, but we put this on hold because of the issue of fee, not research fee but fee on the QA, a percentage of certain production volume of VCO produced. We got the reaction from the members, they said maybe we can get grant funding for the meantime, maybe for the first year, because we might not afford it. It will make VCO very expensive. Then we're getting suggestions from the members that may be it is high time now to continue with QA and then agree on the fee. Basically, what we're going to do is not to repeat the whole process again of PCA and/or BFAD registration. We will just find a mechanism to gather all regulatory agencies and the private sector and make a joint QA system to make it a public-private initiative. We have not planned it but we will again discuss how to go about it during the first quarter of 2007.

Dr JZ GALVEZ TAN: One last word on what Dr. Florentino presented. *Hindi po suntok sa buwan 'yan.* As you all know, Mr. Warren Buffet donated US$ 40 billion to the Bill and Melinda Gates Foundation. And if you have been opening the website, the global challenges for health which is

worth US$ 200 million is allotted for natural products for protozoal diseases, antimicrobials and others. And I think the secret for the Bill Gates funds, because I do get Bill Gates funding, is we need a united front. The country has to come up with a single proposal, nothing will happen if we act individually. I am just giving you a tip and I hope that from now on, we will act together in concerted efforts. Of course I am not demeaning the different offers coming from other agencies. Let's do all we can because we need all the money that we can get.

Thank you very much.

Synthesis 2

Jaime C. Montoya, MD, MS

Executive Director, Philippine Council for Health Research and Development, Department of Science and Technology

I am here to synthesize the highlights of the afternoon session.

Our first speaker, Dr. Rody Sy presented some population studies that showed direct correlation between increased cardiovascular mortality and dietary fat consumption. From the Framingham study he also cited long term studies on the direct correlation between cholesterol and coronary artery disease. There were also studies done on healthy subjects involving intervention with coconut oil, which significantly increased HDL levels but no effect on total cholesterol, LDL and triglycerides. With regard to the meta-analysis of studies on the effect of VCO on lipids, majority of studies showed no change as far as LDL, HDL, triglycerides and cholesterol is concerned. However, there is large variability on the studies in terms of effect of VCO also on lipid profile so further studies need to be done in this area.

On a general conclusion, we can say that as far as the role of VCO on CVD we can talk of a Class II-B recommendation which means that the results are conflicting as of now and the levels of evidence are not of the placebo-controlled studies which we should aim for and the level of evidence is based on expert opinion. This means that we have to actually do more studies on the direct correlation between VCO and CVD mortality and morbidity.

In summary, Dr. Sy mentioned that VCO association studies in population were shown to be highest in the areas with high CNO intake as regard to low CVD mortality. However there is still no existing direct evidence to show direct cause and effect between CNO intake and cardiovascular mortality.

Dr. Vermen Verallo-Rowell presented a number of studies on the use of VCO in dermatology. She was able to show, on a limited number of studies, a comparable activity against a number of gram-positive and gram-negative organisms of VCO as compared to six standard antibiotics against common bacterial organisms. She also produced one study that showed comparable activity between 70% ethyl alcohol and 15% lauric acid as far as antiseptic activity is concerned. As a topical agent, Dr. Verallo-Rowell simply mentioned that there is no adverse effect of VCO compared to standard mineral oil as moisturizer and, in fact, she recommended coconut

oil as a better alternative because VCO does not produce redness, scaling, roughness and erythema which is expected from mineral oil. She also mentioned future studies such as the potential evaluation of the effects of VCO on cancers based on an initial study published in the New England Journal of Medicine on the association between low fat diet significantly reducing sun-induced actinic keratosis (AK).

The study of Dr. Jojo Mantaring actually focused on the effect of VCO on low birth weight (LBW) infants looking at two primary outcomes: its effect on mortality and the risk of sepsis and weight gain parameters. As a conclusion, he mentioned there was no significant difference as far as outcome is concerned when you talk of mortality. However, there was a 50% reduction on the risk for sepsis for LBW infants compared to those not given VCO. There was also a significant effect on reducing the duration of intervention, which may result in a significant drop in hospitalization cost because this will result in shorter hospital stay. Based on the intention to treat analysis, Dr, Mantaring was able to show 7-9 point to prevent 1 case of sepsis development. There was also no increase in the risk of feeding intolerance when babies were given VCO and there was no significant increase in growth parameters.

For the reactions, Dr. Jody Dalmacion actually mentioned that most of the studies are following the right direction in that we have to follow the experience in herbal medicine research in which we have to establish first the proof of principle, then proceed to basic studies, then going to clinical research which will be used eventually by the industry.

Dr. Rodolfo Florentino mentioned that there is a need to do more scientific studies, probably multi-disciplinary, multi-level studies addressing some of the current health issues on VCO; to do more randomized controlled trial on the effect of VCO on health indices and diseases. He also mentioned the need to do *in-vitro* experimental and observational studies to evaluate the anti-inflammatory, immunomodulatory, antimicrobial and possibly, the anti-obesity properties of VCO. He also mentioned the need to do more cross-sectional studies with reference to studies done by the National Health Survey and FNRI.

Based on the feedback and open forum, it was actually highlighted there that there is a need to standardize VCO as far as composition and processes is concerned in order to help the industry. There is a need to implement quality control measures, which should also be standard for VCO and the importance of doing clinical trials which should provide the evidence for the health benefits of VCO. A very important recommendation was the establishment of Philippine National Coconut Oil Regulatory Board, which will probably be the oversight body for regulatory, pricing, quality control, production and eventual directions for studies on VCO. There were also

comments from concerned agencies such as VCO Philippines, Inc. and the Philippine Coconut Authority as far as their willingness to support studies on VCO.

Lastly, may I say that PCHRD, being the lead Council for health research in the country, has already initiated the integration of national efforts as far as health research is concerned through the establishment of the Philippine National Health Research System (PNHRS). We have already developed the National Unified Health Research Agenda (NUHRA), which is the common direction for health research until 2010 formulated by the lead agency, which is the DOST-PCHRD, together with the Department of Health, Commission for Higher Education, and the National Institutes of Health – UP Manila. It is important to mention the NUHRA, because in this particular aspect of health, we have to strike a balance between public health needs and industry needs. I have to always repeat on this because for everything that the industry requests from us, we have to also remember that the other side of the coin is public health needs; and the public health needs do not necessarily always equate with the needs of the industry. That is why you are in the position to actually determine and to provide a balance between these two aspects. We cannot just side with the industry and we cannot just side with public health. There has to be a balance between the two and that is the critical role of the Council and the PNHRS.

We have to make a balance also between the sectoral needs and the needs of the general population. I mentioned this because when we look at funding, one of the dimensions we want to follow is that we would also like to identify the needed support to sectoral needs, to identify sources for those sectoral needs. For example, for the sector of VCO, of course we hope that most of the support will be coming from the industry because that is the sector you are involved in. In much the same way that is, for example at malaria, we look at a sector that is actually most active in the area of malaria and the rest.

We also need to discover new sources of funding. This cannot be overemphasized. There can never be sufficient amount of money for health research. If more money comes in, more projects are generated and more demands and more needs are identified. In order to answer this, let me also mention that we filed a bill in congress both in the lower and upper house. We call it the Philippine National Health Research System Act of 2006, which will institutionalize the PNHRS and more importantly the sustainability of health research system in the country by having government agencies enlist and commit contribution to the Philippine National Health Research Fund. We would like you to be advocates as well for this bill because I think when this bill is passed into law, it will basically answer almost all of the problems the industry is facing now because we will not be contending any more with problems of support as far as health research is concerned. The

talking point that we have as far as the bill is concerned is the urgency of having an integrated health research system in place.

I am happy to say that the President has already confirmed signing the certificate for urgency for such a bill to be passed because we cannot address the emerging health problems such as SARS and the impending threat of avian flu if we do not have an integrated national health research system in place. We have no way of devising an immediate system of response to protect Filipinos from such threats. This is what I have to say on the PNHRS Bill and I hope that you can be advocates just like us in pushing for the immediate passage of this bill.

Finally, I'd like to say congratulations to everyone for a very successful meeting and rest assured that the PNHRS does consider the health sector as a very important sector. Specifically, the VCO is one of the priority areas for research as stipulated also by the 8-point agenda of the DOST. So, we hope that we will be able to galvanize and strengthen the partnership between us—the government sector; and you—the private sector.

Thank you very much.

Closing Remarks

Patricio S. Faylon, PhD

Executive Director, Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development, Department of Science and Technology

Good afternoon to all of us.

First of all we would like to recognize the various speakers, they are at the core of this activity. *Sila talaga ang naging buhay natin.* Of course, we have our scientists and academicians, our friends, particularly from the private sector and we are very happy to know that the administrator of Philippine Coconut Authority (PCA), Congressman Garin is with us. We have a very long relationship with him and now that he is at the PCA, we hope that he will be with us in pushing the initiatives on VCO.

So I guess at this point, we are all convinced that really coconut is a wonder tree. Even at this age of computers and robotics, the coconut continues to amaze us and it really lives up to its name as the tree of life. We thought that we have already exhausted all its edible and non-edible uses. Yet here we are in this forum, discussing other important uses of coconut, particularly in the area of human health. For the whole day, we delved on the benefits of coconut oil—a far cry from the propaganda launched by developed countries brandishing that the coconut oil, along with other tropical oils, poses risk to human health.

The coconut oil, particularly the pure form, the virgin coconut oil, has health benefits, which were exhaustively and convincingly discussed by our resource speakers today. This symposium, which is about to end, marks another big step towards the promotion and advancement of VCO. There is no doubt that this major event is another success in the history of coconut, VCO in particular.

Mr Carpio, in his talk this morning, said that in year 2000 during the beginning of the VCO industry in the county, there was very little information and business at that time. Since then, a lot has been done regarding VCO. I believe the efforts of Dr. C Dayrit on HIV have really triggered our renewed interest on VCO.

PCA pointed to us that 2,000 mt of VCO was produced in 2001, increasing to 19,000 mt in 2002 and 364,000 mt in 2005. Such increase in production was in synchrony with the increased interest in the benefits of VCO even in the international market, where export volume increased

from 1.8 to 475 mt from 2001 to 2005, respectively. These 475 mt are valued at US$ 1.6 million. The booming industry of VCO in the international and local market encouraged the development of the Philippine National Standards for VCO, to protect this industry. I think it is appropriate to mention the different agencies which continually work on this which include, among others, the Center for International Trade Expositions and Missions of the Department of Trade and Industry, Philippine Coconut Industry and the Bureau of Agricultural and Fisheries Product Standards of the Department of Agriculture.

Today's Symposium on VCO: State of the Art which aims to review the current state of VCO standards, health effects and set the priorities for future directions in VCO production, standards and health research is indeed very timely. Where we are right now and what else we could do to improve our product and become more competitive in the world market is, of course, very essential. We must keep our market niche at the highest to continually provide our farmers with the best price for their produce.

It is remarkable to note that in such a short time, what originally were health claims on VCO are now supported by scientific studies, particularly on the effects on cardiovascular diseases, viral diseases, dermatologic disorders and, of course, in improving survival of neonates. We acknowledge the fact that VCO is categorized as health supplement at the moment, and not yet a drug, but given such effects as discussed by our speakers, VCO has a long way to go as more benefits are unraveled and more scientific evidences as to its efficacy are documented.

Today, VCO has proved to be a promising and excellent product, which we can be proud of. The absence of a set of international standards for VCO will give our country the chance, if we are able to develop the standards, to be a pioneer in setting up such a standard. At present, I think that we are still ahead in the VCO race with our neighboring countries but we must not be complacent as other countries are very keen to capitalize in the growing global market and interest in VCO. I believe that with all of us working together, we will have a good chance of harvesting the benefits of VCO and ultimately our people would benefit from it.

From the NAST, in particular, and the DOST, as a whole, we would like to express our sincere appreciation to all the sponsors and organizers of today's forum. We hope to have more dialogues such as this, so that we will always be on our toes with regard to VCO.

Thank you very much. Good afternoon.

Appendix

Position Paper on Coconut Oil

NAST National Committee on Coconut Oil Research for Health

In response to the statement in the 1 October 2004 letter of 11 US Senators to the US Secretary of Health and Human Services and to the Commissioner, US Food and Drug Administration (FDA) that "oils that are high in saturated fats may be almost as conducive to heart diseases as partially hydrogenated oils," and that was transmitted by Mr. Victorino B. Leviste, Agricultural Attache, Embassy of the Philippines in Washington, DC, USA to the Department of Agriculture, Manila, Philippines, the NAST Multisectoral National Committee on Coconut Oil Research for Health was asked to prepare the following position paper to clarify the unique composition and properties of coconut oil, relative to other oils, for transmittal not only to the friends of the Philippines at Capitol Hill and relevant officials in the US Department of Health and Human Services and the US FDA, but also in the Philippines, through its Advocacy Subcommittee and other means, to inform Filipino consumers of the true merits of coconut oil.

Based on the classification of fatty acids into:

a) Saturated fatty acids (no C=C double bonds)
   Medium-chain fatty acids (MCFAs, 8 to 12 carbon chains)
   Long-chain fatty acids (LCFAs, 14 carbon chains and longer) and
b) Unsaturated fatty acids, containing double bonds:
   Monounsaturated fatty acids, with one double bond, and
   Polyunsaturated fatty acids with two or more double bonds,

Coconut oil has about 63% saturated MCFAs [about 48% lauric (C12), 7% capric (C10) and 8% caprylic (C8), 92% total saturated fatty acids, 6% monounsaturated fatty acids and 2% polyunsaturated fatty acids (Codex Alimentarius, 2005)(Table 1).

Coconut oil, with very low (2%) polyunsaturated fatty acids, is very stable and resistant to oxidation, and is an excellent cooking oil. It does not release free radicals. On the other hand, the polyunsaturated fats (Table 1) easily generate free radicals, which damage our cells.

Since coconut oil is naturally saturated (>90%), it does not need hydrogenation. Hence coconut products have no *trans* fatty acids. *Trans*

Table 1 Mean content of medium- and long-chain saturated fatty acids, monounsaturated and polyunsaturated fatty acids and *trans* fatty acids (wt % of total fatty acids) in selected and hydrogenated vegetable oils and lard, in contrast to oils from coconut, human milk and cow's milk (Souci et al, 1986; USDA, 2007).

Oil source	Saturated fatty acid (%)			Unsaturated fatty acid (%)	
	Medium-chain	Long-chain	Total	Mono-( )[b]	Poly-( )[c]
Coconut	62[a]	30	92	6 (0)[b]	2 (0)[c]
Palm kernel	57[a]	29	86	12 (0)	2 (0)
Cow's milk	13[a]	52	65	28 (0)	7 (0)
Human milk	8	40	48	40 (1-5)[b]	12 (0)
Lard	0.2	41	41	47 (0)	12 (0)
Palm	0.1	51	51	39 (0)	10 (0)
Olive	0	14	14	76 (0)	10 (0)
Canola	0	7	7	62 (0)	31 (0)
Corn	0	14	14	29 (0)	57 (0.3)[c]
Soybean	0	15	15	24 (0)	61 (0)
Hydrogenated					
Coconut	62[a]	38	99.7	0.3 (0.3)[b]	0 (0)
Palm kernel	53[a]	47	99.7	0.3 (0.3)[b]	0 (0)
Canola	0	11	11	74 (24)[b]	15 (4.4)[c]
Corn-soybean margarine blend	0	20	20	49 (26)[b]	31 (0)

[a] Includes <1% short-chain fatty acids, mainly caproic C6.

[b] *Trans*-C18:1 content in parenthesis.

[c] *Trans*-C18:2 content in parenthesis.

fatty acids, which are formed by partial hydrogenation of polyunsaturated fats (Table 1), lead to high blood cholesterol, high low-density lipoproteins (LDL) and low high-density lipoproteins (HDL)(Mensink and Katan, 1990; Willett et al, 1993; Ascherio and Willett, 1997; Lichtenstein et al, 1999).

Coconut oil MCFAs enter directly into the portal vein, are transported directly to the liver to immediately provide energy, and **not** deposited as fat (Hashim et al, 1964; FAO, 1994). By contrast, LCFAs are esterified within the intestinal cells, enter the lymphatics and general circulation via very-low density lipoproteins (VLDL) to be utilized by the cells and deposited as fat.

Coconut oil is thermogenic (Baba, 1982; Hill et al, 1989; St-Onge et al, 2003), raises the metabolic rate of the body, and prevent accumulation

of fat (Gebliebter, 1980; Gebliebter et al, 1983). It can even cause weight loss. The effective energy value of medium-chain triglycerides (MCTs) from coconut oil is 6.8 kcal (28.5 J)/g (Ingle et al, 1999), while other fats and oils have 8-9 kcal (33.5-37.7 J)/g.

Coconut fatty acids, particularly lauric acid are antimicrobial and kill *in vitro* lipid-coated viruses, bacteria, fungi and protozoa, including tuberculosis mycobacteria, human immunedeficiency virus (HIV), and *Helicobacter pylori* (peptic ulcer) bacteria (Kabara et al, 1972, 1977; Hierholzer and Kabara, 1982; Kabara, 1985). Human milk contains MCFAs, like coconut oil (Table 1). Infant formulas derived from cow's milk are being fortified with coconut oil or MCTs to protect the baby from infection (Isaacs et al, 1990).

Coconut oil with its MCTs is useful for critically-ill patients and those with problems with fat digestion (Ball et al, 1993; Jiang et al, 1991), including premature infants (Graham et al, 1973; Tantibhedhyang and Hashim, 1975, 1978).

Coconut oil does not raise cholesterol level in the blood (Hashim et al, 1959; Prior et al, 1981; Blackburn et al, 1989; Kaunitz and Dayrit, 1992). In fact, coconut oil benefits humans by maintaining or increasing HDL in the blood (Norton et al, 2005).

Summary

Among the edible fats and oils, coconut oil is not only nutritious, but may offer better health benefits than comparable vegetable oils, because of its unique fatty acid composition and metabolism. Because of its very low (2%) content of polyunsaturated fatty acids and high (>90%) content of saturated fatty acids, coconut oil is an excellent cooking oil, very stable and resistant to oxidation and free-radical formation, which damage cells. Coconut oil does not need hydrogenation, which results in the formation of *trans* fatty acids, consumption of which leads to high blood cholesterol, high LDL and low HDL in partially hydrogenated polyunsaturated fats.

Because of its high content (67%) of saturated MCFAs, particularly lauric acid, coconut oil fatty acids enter directly into the portal vein and transported directly to the liver to immediately provide energy, unlike long-chain fatty acids that are deposited as fat. Coconut oil is thermogenic, raises the metabolic rate of the body and prevents accumulation of fat and can cause weight loss. Coconut oil MCFAs, particularly lauric acid, have antimicrobial properties. Thus, infant formulas derived from cow's milk are being fortified with coconut oil or MCTs to protect the baby from infection. Lastly, coconut oil does not raise cholesterol level and may even increase HDL in the blood.

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