INSIDE

THEME

Research in Coconut Sector

Strong foundation of research needed for the bright future of coconut farmers

Dear Coconut farmers,

We have completed a century of coconut research in India in 2016. Significant achievements have been made through the century old research work carried out in various disciplines like coconut crop improvement, crop production and protection, crop physiology, post harvest technology and best disease management practices. Multipronged research works are also undertaken to enhance the competitiveness of Indian coconut sector in the global scenario.

In the present era of emerging issues, there is need for more research focused in priority areas in coconut sector. Coconut is prone to various pest and disease attack and control measures have been developed for most of them. For diseases like Thanjavur wilt in Tamil Nadu and Ganoderma wilt in Karnataka, management strategy has been evolved and recommendations are available for farming community. Inspite of more than 15 years of research in root (wilt) in Kerala a proper cure is yet to be evolved. Due to changes in climatic conditions many new pests appear everyday. Evolving pest and disease resistant and tolerant dwarf cultivars and hybrids in India is the need of the hour. CPCRI has evolved a few dwarf cultivars which are reported to be tolerant to some of the diseases. But seedlings of these cultivars are not adequately available to meet the requirement of the farmers. Therefore, evolving research on developing new dwarf cultivars and developing hybrids of new combinations which are pest and disease resistant is an urgent need.

Research in coconut sector is mainly carried out by ICAR Institutions. State Agricultural Universities are also undertaking coconut based research. Coconut Development Board (CDB) is trying to undertake research on product development and value addition under sponsored research programmes under Technology Mission on Coconut (TMOC) in collaboration with research institutes like Central Food Technological Research Institute (CFTRI), Defence Food Research Laboratory (DFRL), Central Plantation Crops Research Institute (CPCRI), Indian Institute of Science Banglore, Central Institute of Fisheries Technology, etc. Private institutes like Amrita Institute of Medical Sciences, Amrita School of Pharmacy and SCMS Institute of Bioscience and Biotechnology are also entrusted with few research projects. Board has recently initiated field research on a very limited scale in farmers' field and also at the Demonstration cum-Seed Production (DSP) Farms of CDB.

Coconut, a crop of high socio-economic relevance in Indian agriculture, supports the livelihood of 12 million rural people. It is cultivated in 2.1 Million Ha in India producing 21,665 Million nuts with a national average productivity of 10,122 nuts per ha per annum. Coconut is gaining importance in the health, nutrition and wellness segments owing to its multiple nutraceutical, cosmeceutical and pharmaceutical properties. But coconut farmers are passing through a very difficult phase due to frequent price fall, pest and disease attack coupled with severe drought in many traditional coconut growing states. This is the context in which this issue of Indian Coconut Journal is focusing on the theme 'the need for strengthening the research in coconut sector for a bright future of farmers.'

Coconut gardens in traditional coconut growing states like Tamil Nadu, Kerala, Karnataka and Andhra Pradesh are affected by severe drought resulting in extensive damages. Coconut is predominatly a rainfed crop without irrigation. Research on evolving drought resistant varieties need to be intensified. Rapid multiplication techniques are yet to be developed in coconut sector, in the production of planting materials. Even though commercial tissue culture has been successful in other palms like oil palm, date palm and arecanut, it is yet to be seriously attamepted in coconut. CPCRI had initiated plumule culture, but the output so far is at a very low level and unable to address the present level of high demand. A dedicated research team with sufficient resource need be set apart with the sole task of rapid multiplication in coconut using latest advancements in biotechnological tools. Resilience to climate change and its after effects in coconut also need to be taken up for research on a wider spectrum. Similarly the carbon sequestration of coconut and its potential for claiming higher carbon credit has not been fully exploited.

Need for new research in coconut value addition through technology development is gaining importance. Through CDB Institute of Technology (CIT) new product development is undertaken. Once technologies are developed and pilot tested for new products, they can be transferred to entrepreneurs and FPOs.

Acceptance of coconut as a source of health nutrition and wellness is being widely accepted. Research on coconut oil undertaken earlier by Sree

Chithira Thirunal Institute of Medical Science and Technology (SCTIMST) clearly revealed that coconut oil is not adversely affecting cardiac patients or increasing total cholesterol nor LDL cholesterol. Subsequent to this research the department of Bio chemistry of Kerala University under the leadership of Dr. Rajmohan conducted further detailed research on various health aspects of coconut oil. Having satisfied with the positive benefits of coconut oil, he guided 17 students in their research for PhD in coconut oil and coconut related sectors. These 17 students who have taken PhD in coconut related topics are now working in various universities, colleges and scientific institutes. Some of them are still purusing their research interest in coconut. Clinical study by Amrita Insititue of Medical Science (AIMS) under the Amrita Vishwa Vidyapeetham University was the first clinical research conducted in cardiac patients using coconut oil. This study clearly established that coconut oil is improving the health and cardiac profile of patients. A study conducted by University of Adelaide in Australia has discovered that coconut oil exterminates 93 percent of colon cancer cells in two days. The study shows that the lauric acid in coconut oil that constitutes 50 percent of its makeup is an active anti-cancer component. Similarly research on various health benefits of Neera is also going on in patients.

Coconut milk, another product from coconut has been proved to be the next best thing to breast milk. According to various studies, lactose in dairy milk is difficult for many people to digest, while coconut milk does not contain the lactose. Hence it can be used as a substitute for dairy milk to those with lactose intolerance. In situations when a baby is not getting breast milk or needs supplements, coconut milk is widely used in place of cow milk. It is a popular choice of vegans and makes a great base for smoothies, milkshakes and as a dairy alternative in baking.

For the first time in India, a young entrepreneur from Tamilnadu has launched flavoured coconut milk in tetra pack on a commercial scale with vanilla, chocolate, pineapple, badam, coffee and cardamom flavours. He is targeting the health conscious consumers on a pan India basis. Similar products imported from other countries are already available in the urban Indian market. We are hopeful that the various research findings on the beneficial effects of coconut milk will create a sound demand for this novel product.

A research study conducted by Indian Institute of Science, Bangalore has found that Neera, the nutritious health drink from coconut is beneficial in the treatment of liver diseases particularly, in treatment of liver cirrhosis.

Coconut Development Board through the Technology Mission on Coconut (TMOC) has developed many technologies for value added products from coconut with the support of CFTRI, DFRL and other institutions. Flavoured coconut milk, neera and neera based products are the new entrants in the field. Compared to the production level and the potential of coconut based industry in India, what we have achieved is quite inadequate. Intensified research need to be taken up further for developing innovative value added coconut products from every part of coconut palm. Presently CDB is extending support for research projects undertaken by scientists of reputable academic institutions. CDB is willing to associate with such institutions for collaborative research for the better future prospects of coconut sector.

The Farmer Producer Organizations (FPOs) in coconut sector has already established their powerful presence in the sector with 9063 Coconut Producer Societies, 696 Coconut Producer Federations and 60 Coconut Producer Companies. FPOs need to take up the responsibility to inform inspire and motivate scientists and researches about the infinite possibilities in developing coconut products. We need to attract reputed educational institutions and good scientists to take up research projects on coconut in a big way. Hence collaborative efforts of coconut farmers through their collectives, academic and research institutions and CDB need to be enhanced for taking the Indian coconut sector to greater heights.

Coconut as a functional food with its nutraceutical and pharmaceutical benefits need to be researched further through clinical trials. International collaboration in such researches for gathering inputs and exchange of information and research results can help coconut farmers in India in a big way. There is urgent need for concerted research initiatives to solve the various problems that haunt coconut sector. Let us keep our attention and interest towards these aspects and focus our future research on such issues for ensuring a bright future for Indian coconut farmers.

With regards

T K Jose
Chairman

'Truth will triumph at the end' - Dr. B.M. Hegde on coconut oil

● **Remany Gopalakrishnan,** Consultant, CDB, Kochi -11

Dr. B.M. Hegde* a medical professor of Cardiology and a person of many meritorious excellence is regarded as the 'People's Doctor'. A Padma Bhushan (2010) laureate, he advocated the advantages of Coconut oil and spoke on the facts and truths about the intricacies in the adverse propaganda on its consumption, which many do not dared to do. Dr. Hegde is an inspiring orator, author of several books, eminent doctor, and able administrator, probably the only Indian to become the fellow of all the Royal Colleges of Physicians of the British Isles including Ireland. Some excerpts of Dr. Hegde's speeches and writings on coconut are sourced here for reproducing in this articles.

Coconut Oil Consumption and Cholesterol

All saturated fats were said to be the reason for the cholesterol induced epidemic of coronary disease. A search for better fats landed researchers in the backyard of coconut palms, washing out the cholesterol myth. Nutritionists and doctors have been advising everyone to avoid coconut oil because of the saturated fat it contains allegedly linked with many diseases. Busting the myths propagated by doctors and nutritionists over coconut oil, Prof. Dr. Hegde says, "I am surprised when people say coconut oil is poison. If a doctor says that it contains cholesterol, it means he has not gone to any medical college. First thing they taught you in any medical school is biochemistry, where students learn that cholesterol comes from animal source. How can a plant like coconut could then become source of cholesterol? After realizing this mistake, they started saying that coconut oil contains saturated fat and hence it is bad". Coconut oil lowers cholesterol in hypercholesterolemics because of its lauric acid content that safeguards the heart through the increase of good cholesterol and decrease of total cholesterol. Regular use of coconut oil in diet would regularize blood fats and is known to increase the HDL cholesterol fraction while decreasing the LDL and triglycerides significantly; disproving the myth that coconut oil increases cholesterol and triglycerides.

Dr. Hegde's frank opinion on the irrelevance of linking coconut oil with cholesterol or cardiac problems was so firm and he even went up to the extent of saying that if coconut oil is poisonous, human beings would have extinct like dinosaurs in coconut growing countries. "We have been here for thousands of years and the cholesterol story is here since the 1940s. Before that, people were using coconut oil. Until the 1930s, even bread in the US was made using coconut oil. Things changed after that and the ghost of cholesterol has given birth to flourish today as the best business says" Dr. Hegde. The powerful lobby of saturated fats could influence the thinking of the medical world through a plethora of studies, all of which were silenced effectively by the vested interest groups.

In America, even today, the infant food is made of coconut oil as fat base, because the new born baby in the first year of his life does not have the pancreatic fat digesting enzyme. Baby has to survive on the lipase in the saliva and the only two fats a baby can digest and survive are the mother's milk and coconut oil. The story of cholesterol and coconut oil is only about half-a century old while the good-old coconut had been an excellent food for thousands of years for the people, especially in the coastal areas. Coconut is a functional food. It not only gives you calories, but it increases your health too. Our cell walls are made up of cholesterol. Every day crores of old cells are dying and new cells are formed. We need cholesterol for our very existence. He further added that cholesterol level depends mainly on genetics. Coconut oil decreases the cholesterol level in those people who are having high cholesterol levels and increases the cholesterol level in those having low cholesterol level. It is not doing any harm to those having normal cholesterol levels. The thyroid function is maintained beautifully by coconut oil and one of the treatments of hypothyroidism is taking coconut oil.

" Recently I had to have an unpleasant experience in a TV debate on coconut oil as the best fat for man, next only to mother's milk, as the fat base of both coconut oil and mother's milk is the vital immune booster, sodium monolaureate. Monolauric acid is found only in mother's milk and coconut oil. The young cardiologist opposing it was lost for data to match to say that coconut oil is poison but he kept on repeating that his books and "guidelines" say that coconut oil is bad! Little did he realize that all the "guidelines" and books are written by company sponsored people".

" 90% of our serum cholesterol is manufactured in our own livers to help keep us alive and only 10% comes from the food, a very small contribution indeed. All drugs that lower cholesterol, by force damage liver functions definitely! Readers could get more details from my web site where many other scientific papers of mine in this field are listed. www.bmhegde.com. I must hasten to add that any fat, even the goodnes like coconut oil and ghee should be taken with care. The total fat intake should not form more than 20% of our total calorie requirement per day".

Coconut oil is next to mother's milk

According to Prof Dr Hegde, coconut oil and mother's milk are the only two items that get digested in the mouth of a baby. "Both, coconut oil and mother's milk contains sodium monolaurate, which is monolauric acid and forms the basis of human immune system." He also said that feeding milk, other than the mother's to infants is not a good option and instead we should use coconut oil. He said milk from larger cows provokes severe anti-body response from the human system as its milk protein is foreign and is antigenic.

Fats are more scientifically classified into three groups mainly based on the number of carbon atoms they possess and the length of the chain. Short chain having between C4-C6 carbon atoms, medium chain between C6-C10 or so and long chain with C11-C24 atoms. Little over 50% of coconut oil is medium chain fatty acid, Lauric acid and another 7-10% is a medium chain Capric acid. Lauric acid gets converted inside the human system into Monolaurins, the best fat that mother's milk has. Other than mother's milk, monolaurins are found only in coconut oil. New born babies and infants depend on the monolaurins for their immune system development and their capacity to withstand any infection. In addition, coconut oil can be digested by the salivary lipase, getting absorbed very fast to give energy like carbohydrates. All other fats need the pancreatic lipase for digestion that the

infants do not have. The best alternative food fat for the infant when mother's milk is not available is coconut oil. Other fats might be dangerous.

He warned that milk from any foreign source is only a time bomb waiting to detonate in the not too distant future. He however admitted that the milk industry is very powerful and it is very difficult to speak the truth. the industry should concentrate more on selling denatured milk, in curds, buttermilk and ghee which are good food instead of milk.

Dr. Hegde's remarks on feeding milk other than breast milk to babies need to be understood in the right perspective. The use of cow milk by human beings has been a point of debate for quite some time. The inevitability of cow milk in human diet is not questioned here. At the same time, we should understand that coconut milk in right dilution can be a good substitute for cow milk.

Coconut milk has been an important ingredient of many cuisines in tropical countries. Indian kitchens have familiarized the taste of coconut milk in age old culinary preparations. But as a substitute for cow milk, much serious thought has not been done. Why ? The answer is, the lesson that cow milk as a balanced diet has gone much deep into our minds. The highly nutritious coconut milk which is rich in fiber, vitamin C, E, B1, B3, B5 and B6 and minerals including iron, selenium, calcium, phosphorous, magnesium and sodium is a healthy substitute to cow milk. Cow milk can be replaced by coconut milk in various dairy based recipes.

While admitting the fact that breast feeding is by far the best option for babies, in the event of a crisis where such feeding is not possible, coconut milk in right dilution can be a substitute for mothers' milk. It is free from chemicals and additives that are present in most formulae and is full of nutrients that a child needs to develop and grow.

There is also a segment of people who are in search of dairy alternative mainly due to lactose intolerance. Coconut milk offers a clear market for this group. Non-dairy milk market is one of the fastest growing consumable product markets in the world. Demand for vegan milk in conventional packing is also on the increase in US and Europe consumable sector. All these shifts in tastes and dietary needs point to the emerging scope for coconut milk in food sector.

The following table shows a comparison of the nutrients present in coconut milk formula and that of milk.

Nutrition Facts	** Breast Milk (36 oz)	Coconut Milk Formula (36oz)
Protein	766g	11g
Carbohydrates	76g	60g
Total Fat	48g	53g
Saturated Fat	22g	41g
Mono Fat	18g	6.6g
Poly Fat	5.5g	1.4g
Omega - 3 FA	0.58g	0.932g
Omega - 6 FA	4.4g	0.831g
Cholestrol	153mg	55.8mg
Vitamin A	946IU	4850IU
Thiamin - B1	0.51mg	0.7mg
Riboflavin - B2	0.4mg	0.7mg
Niacin - B3	1.9mg	4.6mg
Vitamin B6	0.12mg	0.8mg
Vitamin B12	0.5mcg	66.6mcg
Folate	57mcg	65.1mcg
Vitamin C	55mg	2.7mg
Vitamin D	480IU	450IU
Vitamin E	9.9mg	0.5mg
Calcium	355mg	112mg
Copper	0.57mg	0.4mg
Iron	0.33mg	6.1mg
Magnesium	37.4mg	72.5mg
Manganese	0.29mg	1.4mg
Phosphorus	151mg	167mg
Potassium	560mg	397mg
Selenium	18.8mcg	5.4mcg
Sodium	186mg	35.5mg
Zinc	1.9mg	1.2mg
Calories	766	723

*Source: Draxe.com, ** Breast milk cannot be substituted by Coconut milk.*

Coconut Oil for weight reduction

Coconut oil contains the healthy and weight reducing form of saturated fat it does not form dangerous transfats that even olive oil does, and it is far healthier than other vegetable oils.

Coconut oil is a low calorie fat and as such helps control body weight. In addition, coconut oil stimulates metabolism to get itself metabolized fast to supply quick energy unlike all other fats. It also encourages weight loss, because there is no circulation of the medium-chain fatty acids in the bloodstream. Coconut oil goes directly to the liver and is then turned into energy. The coconut oil's fat is therefore not stored as fat by the body; instead, the body utilizes it for energy. This also helps control body weight. Changing the food fat to coconut oil could help reduce weight in obese individuals. It also helps to control blood fat levels in diabetics. Because most of coconut oil is medium chain fat and it gets absorbed and metabolized so fast that it rarely gets transported to fat depots like other fats, altering the lipoprotein fractions of blood, another great boon. Coconut oil contains so many anti-oxidants that it resists oxidation even if it is preserved for as long as a year whereas all other fats are oxidized and have become transfatty acids by the time they come in the food shelves! Coconut oil resists oxidation even on boiling at 76 degree centigrade. So there are no transfats in coconut oil. While fried foods are not good for health, if fried in coconut oil, foods are not that bad.

Addressing an International Conference on Coconut Biodiversity at CPCRI, Kasargod, Dr. Hegde suggested the use of coconut oil instead of butter on toast, English muffins, bagels, grits, corn on the cob, potatoes or sweet potatoes; add coconut oil or milk to your favorite smoothie recipe; mix coconut oil into oats or other hot cereal, rice, vegetables, noodles, pasta, 50:50 with salad dressings, soup, chili or spaghetti sauce.

Coconut oil for diabetes and skin disease

According to Dr. Hegde, coconut oil in any form is good, but one should use virgin coconut oil for treatment. It is extracted from fresh coconut kernel without any chemical processes and is the purest form of coconut oil. Virgin coconut oil controls diabetes, because the insulin in the bloodstream does not go up. Virgin coconut oil also nourishes the brain, according to studies which show how consuming it enhances cognitive function. It also reverses or stalls neuro degenerative diseases during the early stages. It has been used for five millennium in India in Ayurvedic medicine.

Coconut oil is having the power to kill fungus and hence it is very good for fungal skin diseases. It is a powerful anti fungal agent. Coconut oil also has been found to be an excellent moisturizer for dry skin conditions. Even severe form of skin infection can be completely healed by just applying coconut oil according to Prof Dr Hegde. Sharing an anecdote where coconut oil cured a skin problem, he said "One of my friends developed a peculiar skin problem. After approaching a dermatologist he was advised for Biopsy. Though nothing happened, the infection got pus. Merely on applying coconut oil, it got healed completely." He also explained the benefits of coconut oil for hair loss and dandruff problem. Coconut oil is said to penetrate to hair roots to keep hair healthy and clean. Another benefit is that it targets the harmful bacteria candida and kills it using its caprylic acid content.

Protection against Cancerous cells

Coconut oil is known to protect human beings against certain cancers also. The type and quantity of fat matters a lot in the growth of the ubiquitous rogue cell in the human body, which is the seed of all future cancers. It is here that coconut oil plays a vital role in discouraging the rogue cell from growing further. Most rogue cells die a natural death in time. Scientific discoveries have shown the most powerful anti-germ properties of coconut. A recent press report on the scientists' discovery that coconut oil exterminates 93% of colon cancer cells in 2 days, recieved with great hopes. This findings need more rigorous *in vivo* research.

Antibacterial, Antiviral and Antifungal effects

The monolaurins in coconut oil have been found to be very powerful anti bacterial, antiviral and antifungal agents. Most viruses, including the retrovirus HIV, are sensitive to coconut oil. A diet rich in coconut oil reduces diurnal postprandial variations in circulating tissue plasminogen activator compared with a diet rich in unsaturated fat in women. There are interesting therapeutic values in coconut oil. A recent report shows how it could be used to treat aluminum oxide poisoning (agricultural pesticide content) for which there had never been any specific antidote so far. According to research, coconut oil heightens metabolism and energy thus stimulating the thyroid functions and is very good for preventing Alzheimer's disease.

There are also reports from medical doctors that coconut products like virgin coconut oil and coconut water have amazing effects on detoxification of cells in cancer patients. The toxins in the cells of liver and kidney are filtering out and impurities are removed by incorporating coconut in the diet of cancer patients. This points to the need for further research on the authenticity of coconut as health and wellness dietary products.

With all the health benefits, coconut has been now classified as a functional food. Functional food was defined as "food that provides health benefits over and above the basic nutrients." No other fat could claim that status except the Indian clarified butter-ghee, which according to Ayurveda is an excellent food for good health and strength.

Thus coconut oil that has been our staple food for thousands of years could not have suddenly become so bad in the 1930s that it had to be thrown out of the window. Our thousands of years of observational research is any way more reliable compared to the short term cross sectional motivated research today. Truth will triumph at the end.

Future Research

Future research can be oriented more towards coconut and health sector. When strong views have been emerged out of the recent findings that coconut and coconut products are the answer to healthy ways of living, there are still apprehension on the consumption of coconut and coconut products especially coconut oil. Focus should be more on clinical studies related to effects of coconut oil on cardiac problems, its protective role against cancer cells, diabetes, weight reduction, skin problems, effect of Neera on the control of liver diseases etc. The ultimate aim of such studies shall be to promote consumption of coconut and widen the market segment. **There are many medical doctors who have revealed immense beneficial effects of coconut oil. Dr. Valiathan, Dr. Mary Enig, Dr. Bruce Fife, Dr. Dayrit, Dr. Sadicot are a few among these. Their findings and observations have strengthened the coconut sector a lot.** Collaborative research programmes both at national and international level are important. A foundation, though not so strong, has been built in with the clinical research so far carried out by Amrita Institute of Medical Sciences, Kerala, India which has to be transcended into a major endevour with the association and help of international research and donor agencies. The ultimate aim of such research interventions shall be to bring out the nutritional and health attributes of coconut.

Coconut oil had the bad time since 1930s, but the time has changed and it is going on to good times now. This good time will continue for all times to come. Long live the coconut tree, the venerated *kalpavriksha*, for the common cause of human being. ■

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Managing coconut to climate change - a priority area in research

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Coconut is cultivated as a rain fed crop in majority of the coconut growing states in India. Rainfall and temperature are two important factors influencing the crop yield. Change in climate affects the normal physiological functions and yield of coconut palm. Optimum weather conditions for good growth and nut yield in coconut are, well distributed annual rainfall between 130 and 230 cm, mean annual temperature of 27°C and abundant sunlight with at least 120 hours per month of sun shine period. Since, coconut is a humid tropical crop, it grows well above 60% humidity.

Impacts of climate variability have profound impact on the production of coconut. Climate change will affect coconut palm through higher temperatures, elevated CO_2 concentration, precipitation changes, increased pest and disease pressure and increased vulnerability of organic carbon pools. An attempt is made in this article to analyze the impact of climate change in coconut and to identify researchable areas for future research.

Effect of high temperature

Increase in temperature affects production in almost all plantation crops. Since coconut is mainly grown as a rain fed crop water stress due to increase in temperature very much affects the productivity. Most often, the productivity is 50% low compared to irrigated gardens. Coconut faces frequent occurrence of increased temperature in summer dry spells each year from December to April. Being perennial in nature, coconut palm has a long duration from the initiation of inflorescence primordia to matured nuts (44 months) with longer pre-fertilization period (32 months) than post fertilization (12 months) period. The inflorescence primordia is to develop in the leaf axils about 32 months before the opening of the inflorescence. The ovary is first differentiated about 6-7 months before the opening of the inflorescence. Seasonal factors prevailing during the developmental stages during the period of 32 months before the inflorescence opens do affect the yield of nut. Hence, the impact of high temperature occurring at any of the critical stages of the development of inflorescence affects the nut yield not only in that particular year but also in the next three years to follow.

High temperature can have both negative and positive impacts on the growth and production of coconut. Negative impacts like added heat stress, especially in areas at low to mid-latitudes is already at risk today, but they also may lead to positive impacts in the currently cold-limited high-latitude regions. The ideal mean annual temperature for coconut to grow is usually 29°C (27 - 32°C). High temperature increases both the photorespiration and the dark respiration and thus the total biomass production goes down. Frequent but short periods of temperature below 15°C result in abnormalities of fruits like production of barren nuts. The production of Neera, another new high value product extracted from coconut inflorescence may also decrease with the increase in temperature and transpiration rate.

It can be inferred that the longer high temperature due to climate change will affect the flowering and nut setting. Besides, quality of nut water, copra and neera yield from inflorescence will also be affected. Hence efforts are required for identifying suitable crop management practices which can mitigate the influence of climate change and increase the productivity of coconut.

Effect of elevated CO2 concentration

Climate change will have negative effects on coconut plantations due to increased temperature and water stress. However, coconut plantations can also be used to mitigate climate change which is an environment service by acting as C sinks to absorb CO2 from the atmosphere and control global warming while giving an additional income to the growers through C trading. Crown initiation and crown growth in coconut is very sensitive to climate change variables. The higher growth rate of plants under elevated carbon dioxide was closely associated with photosynthesis. It is reported that high temperature decreases the biomass production. High temperature in addition to drought had a compounded effect and reduce the biomass production. To a certain extent,

the elevated carbon dioxide could offset the negative effect of temperature in coconut. The stimulatory effect of carbon dioxide under drought and high temperature is less and it can increase the biomass. This is another area identified for future research.

Effect of precipitation changes

Among the factors affecting climate change, rain fall is also one of the important parameters. Coconut is cultivated as a rain fed crop and a well distributed annual rainfall between 130 and 230 cm has been considered ideal for coconut. Coconut is an extravagant consumer of water. It is estimated that water consumption of tall variety coconut in India is 115 L in summer and 55 L per day in winter whereas the Dwarf varieties consume 30-55 L water. It is reported that dwarf varieties use water more extravagantly due to its elevated transpiration rate, greater number of stomata per unit leaf surface, lower wax content on the leaf surface and poorer stomata control of water loss. Tall varieties, in contrast, show a more conservative water use. This is another critical area identified for future research.

Effect of disease and pest infestation

The insight of climate change will be manifested in emergence of new pathogens and insects in coconut. Increase in the incidence of disease and pest attack result in the use of chemical pesticides to control disease and pest attack will create serious problems in the ecosystem. For example, attack of the pest mite will be more severe in summer months. The effectiveness of pesticide may be low at increased temperature. High temperature will result in speedy decomposition of organic matter in the soil and soil fertility status. Climate change will also affect the natural enemies of beneficial insects which help in the management of harmful insects. We should not delay to start research programmes for understanding the mechanism of emergence of new races and status of pathogen or insects particularly with reference to climatic conditions in various coconut growing regions. Besides adoptive changes, beneficial insects and their number need to be investigated with reference to expected climate change.

Effect of Integrated Farming approach

Studies conducted at CPCRI and elsewhere indicated that coconut based farming system approach is the best adaptation strategy to overcome the effect of climate change. In coconut based farming system, coconut trees are planted as a base crop and all other crops are intercropped using the vertical and horizontal spaces between coconut trees. Coconut is a tree which has no branches and grows straight vertically upwards providing more and more space under its canopy. Its leaves are such that it allows sun light to the crops grown under it. Because of the peculiar characteristics of this tree coconut based farming system (CBFS) is quite different from other farming systems. CBFS is a combination of multiple cropping systems in vertical and horizontal dimensions. Integrated farming approach is effective in mitigating climate adversaries. Climate change phenomena will affect the selection of inter/ mixed crops in coconut based integrated farming system. Thus efforts are needed to see possible threats to the existing CBFS in different regions. However scaling up of research efforts is required in this area also.

Conclusion

From the analysis of the effects of climate change in coconut, it is concluded that managing coconut for resilience to climate change and its after effects need to be studied on a broader spectrum. Studies to evolve dwarf and hybrid varieties resistant to high temperature and ensuring its availability in drought prone areas is another priority of future research. Identification and utilization of climate resilient variety coconut genes from existing cultivars and those available in other countries should be given priority in research. Efforts are needed for development of suitable crop management practices which can mitigate the influence of climate change and increase the productivity of coconut. It is high time to refine the existing technologies for mitigating the impact of climate change on coconut productivity. ■

Research for a better tomorrow

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Scientific innovations and technology developments coupled with efficient extension activities is the key to reaching the objectives of better productivity, production and value addition of any crop. Be it quality seedling production, improved growth and higher yield, or product development, continued and consistent research is inevitable for bringing out remarkable results. There is also a vital need for technology revolution which can address major issues of the sector. Facilities should be there to link farmers, extension workers, entrepreneurs and scientists so as to connect all the stake holders involved in the sector.

Coconut Development Board (CDB) has been implementing the scheme 'Technology Mission on Coconut' (TMOC) from the year 2001 onwards to address the problems in coconut cultivation and bridge the gaps through appropriate programmes in a mission mode to ensure adequate, appropriate, timely and concurrent action. The focused area of the mission is Research and Development in areas of management of pests and disease affected coconut gardens and processing and product diversification.

The eligible institutions for taking up research projects would be ICAR, State Agricultural Universities, State Agriculture and Horticulture Departments and private organizations having the capability for conducting the research. CDB has been continuously promoting research under various components through research institutions such as Central Food Technological Research Institute (CFTRI), Defence Food Research Laboratory (DFRL), Central Plantation Crops Research Institute(CPCRI), Indian Institute of Science, Kerala Agricultural University, Tamilnadu Agricultural University, Central Institute of Fisheries Technology, etc. Other reputed institutes like Amrita Institute of Medical Sciences, Amrita School of Pharmacy, SCMS Institute of Bioscience and Biotechnology Research and Development etc have also been entrusted research projects under TMOC.

Addressing the future research in coconut sector would necessitate identifying the existing problems faced by the coconut farmers and entrepreneurs. One of the burning problems faced by the coconut sector worldwide is the unavailability of disease free quality planting materials. Replanting of old, senile, diseased and unproductive coconut gardens and establishment of new gardens demands quality seedlings. One seed to one seedling also necessitates the need for a more reliable and faster method of seedling propagation. CDB has supported research projects carried out by AICRP (Palms) and CPCRI for mass production of quality seedlings through establishing nucleus seed gardens for coconut. CPCRI and TNAU are also being supported for developing and standardizing repeatable protocols for seedling production in coconut through tissue culture, as tissue culture is one of the feasible alternatives for the rapid production of 'true to type planting materials. As coconut is one of the most recalcitrant species to regenerate under *in vitro* conditions, it has been a difficult task to achieve success in these attempts. However the growing need for superior quality planting materials necessitates carrying out more research to standardize tissue culture/plumule culture which could pave way for large scale production of disease free and superior quality planting materials.

Another prime area of research in coconut is integrated management of pests and diseases. As a result of the technologies developed and demonstration programmes for pest and disease management, many of the serious issues affecting coconut gardens could be brought under threshold level throughout the country. Use of bio agents and other environmental friendly methodologies have been successfully developed and is being popularized among the farming community. Advanced research in this regard is being done at lab level in National level institutes and State Agricultural Universities. The need for community based operations in integrated pest and disease and nutrient management especially for a crop like coconut has to be emphasized and focused in demonstration oriented research projects.CDB has taken

up demonstration projects in association with CPCRI and State Agriculture Departments for effectively bringing down the pest and disease problems in the field. Timely interventions are needed in farmers fields to ensure that scientific practices are being adopted by farmers for integrated pest, disease and nutrient management. The initiatives such as Satellite Production Centres(SPC) under Krishi Vigyan Kendras are appreciable as this will help the farmers in more efficient and scientific farming practices. Future research should bring in systems where all the line departments involved in latest scientific research should be linked and results made available to farmers/ entrepreneurs which would help to bring better yield and higher productivity.

International research organizations are giving more importance for research on studies highlighting the health benefits of coconut and coconut based foods. Virgin coconut oil, termed as "Mother of all oils" is described as cure for many ailments including Alzheimer's disease. The presence of Medium Chain Triglycerides(MCT) in VCO is found to be beneficial in providing energy to brain as well as stimulate healing and repair. VCO has about 50% lauric acids, having qualities similar to mother's milk, thus confirming its disease-fighting ability. Ayurveda is known to use VCO as an ingredient in many of its traditional medicinal preparations. The health implications of VCO need to be explored more as there is a growing demand for VCO throughout the world on account of its high value.

Similarly the qualities of tender coconut water as a natural isotonic beverage is well known. The scope and possibilities of research studies in tender coconut water are immense and need more serious attention.

Innovative product development is another important area to be focused in research. Countries which have less area under coconut have developed novel coconut based food products with better shelf life. The demand for health based coconut food products are on the rise and it is this demand that is being exploited by these countries. Coconut based health nutrition powder, coconut milk based beverages, coconut kernel based ready to eat snacks, candies, jellies, Nata- De-coco based coconut water beverages etc. are being produced on a commercial scale in many countries. In the limelight of world turning towards organic safe foods, coconut based products in these lines would also catch up in a faster mode.

It is in this context that research institutes like National Institute of Food Technology Entrepreneurship Management (NIFTEM), Haryana, Indian Institute of Crop Processing Technology (IICPT), Thanjavur, College of Food Processing Technology and Bio energy, Anand where cutting edge research on food processing is being carried out, can play a major role. The coconut processing industries in our country need modernization to face the challenges of globalization. It is the need of the hour for research institutes to take up high end research to equip our entrepreneurs and industries to tackle their issues and to mould them to a level of world class entrepreneurs.

India being the largest producer of coconuts, it is high time that our R& D organizations identify this as a blooming opportunity to venture into more practical oriented research which can ultimately be beneficial to the farming community. ■

2016-17 expects surge in coconut product exports

V.C. Vasanthakumar, Assistant Director, Foreign Trade and
K.S. Sebastian, Assistant Director, Export Promotion, CDB, Kochi-11

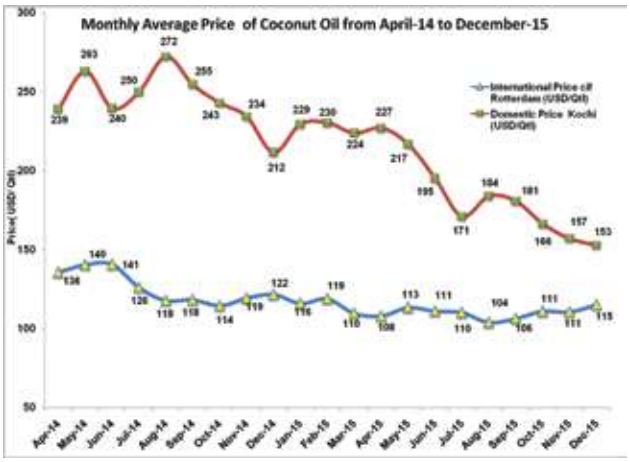
Export value of coconut products from India during 2015 -16 touched a record high of 1450 Crore, which was only Rs. 1312 Crore during the previous year, recording an increase of 10.5% over the year. Even though this is the lowest increase observed after the Board was nominated as EPC in 2009, amid falling total merchandise export of India during 2015-16, which recorded a negative growth of around 10%, this two digit growth shown by coconut sector is highly commendable. Activated carbon, coconut oil, dry coconut, desiccated coconut, fresh coconut and virgin coconut oil are the major coconut products exported from India. All these products enjoy good demand in the international markets, but the export performance in coconut sector does not commensurate with India's coconut production. In spite of being the global leader in coconut production, with a contribution of about 31% to the global production, the export of coconut and its value added products from India constitute only around 5% of the total global export of coconut products.

Among the coconut producing countries, the domestic price of coconut products in India was always ruling higher compared to the international price. Due to the advantage of having high domestic demand coupled with the relatively high domestic price prevailed for the products compared to the international price, the coconut processing sector of India was not thinking of exports till recently. Even though many value added products are made from coconut, the price of coconut depends on the price of coconut oil in all the major coconut growing countries. Table -1 shows the average monthly domestic price and international price of coconut oil during April 2014 -December 2015. It could be seen from Table that the domestic price was more than 100 % of the international price during many months.

Monthly Average Price of Coconut Oil (USD/Qtl)- April 14 to Dec-15

Month	International Price cif Rotterdam	Domestic Price Kochi	Percentage Variation
Apr-14	136	239	76
May-14	140	263	87
Jun-14	141	240	70
Jul-14	126	250	98
Aug-14	118	272	131
Sep-14	118	255	116
Oct-14	114	243	112
Nov-14	119	234	96
Dec-14	122	212	74
Jan-15	116	229	98
Feb-15	119	230	94
Mar-15	110	224	104
Apr-15	108	227	110
May-15	113	217	91
Jun-15	111	195	76
Jul-15	110	171	55
Aug-15	104	184	77
Sep-15	106	181	70
Oct-15	111	166	50
Nov-15	111	157	42
Dec-15	115	153	33

Table -1



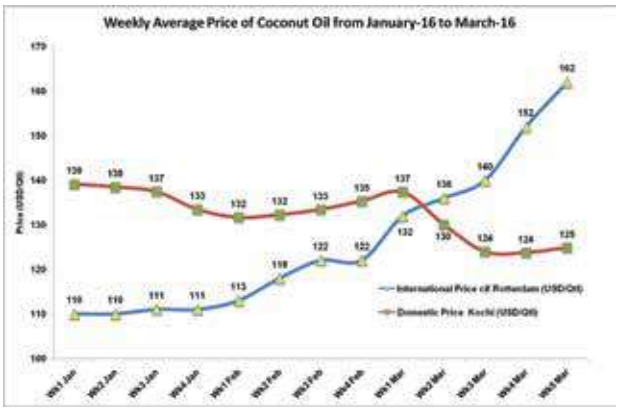
The high domestic price of coconut products was the major reason which adversely affected the growth of the export. Since the price of coconut shell is closely linked with that of coconut, domestic price of coconut shell charcoal was also ruling high during this period, which directly affected the export of Activated Carbon, and the manufactures were forced to fulfill their export orders by importing shell charcoal, which is the raw material for Activated Carbon

Brighter than the past

As far as coconut export is concerned, rays of hope are brighter for 2016 -17. After a long period, a situation has emerged which reversed the international and domestic price scenario. In the beginning of 2016, the gap between international and domestic price narrowed down and it got reversed by the beginning of March. Now, the international price is ruling higher than the domestic price, which in turn paved the way for the opportunity to export coconut products from India with much competitiveness in price than Philippines and Indonesia, the stalwarts in coconut product exports. It could be seen from table 2 that the international price has exceeded the domestic price since the second week of March. The weekly average international and domestic price of coconut oil from January 2016 to March 2016 is shown in Table 2.

Average Weekly price of Coconut Oil (USD/Qtl) - Jan 16 to Mar 16)			
Date	International Price cif Rotterdam	Domes-tic Price Kochi	Percentage Variation
Wk1 Jan	110	139	26
Wk2 Jan	110	138	26
Wk3 Jan	111	137	24
Wk4 Jan	111	133	20
Wk1 Feb	113	132	16
Wk2 Feb	118	132	12
Wk3 Feb	122	133	9
Wk4 Feb	122	135	11
Wk1 Mar	132	137	4
Wk2 Mar	136	130	-4
Wk3 Mar	140	124	-11
Wk4 Mar	152	124	-19
Wk5 Mar	162	125	-23

Table 2



In case this price advantage is continued and our exporters are able to tap the full benefit out of this situation, undoubtedly 2016 – 17 is going to be the golden year Indian coconut sector.

Decline in Import

The total value of coconut products imported to India during 2015 – 16 was Rs. 383 Crore. The major products imported were copra oil cake (204 Cr), coconut fatty acid (62 Cr.), coconut oil (45 Cr) and coconut shell charcoal (37 Cr). Among these, all products, except coconut fatty acid are being manufactured in India in large quantities. Further, as the domestic price of these products is below the international price at present, a significant decrease in import of these products is expected during 2016 -17.

Coconut Fatty Acid

Coconut fatty acid is a family of different types of fatty acids derived from coconut oil. It is produced through the hydrolysis of coconut oil. Like any other edible fats and oils, coconut oil is a mixture of chemical compounds called glycerides, which is a combination of glycerol and fatty acids. Coconut oil upon hydrolysis yields about 85 % of fatty acids and about 15% of glycerol. The stage of maturity of coconut at harvest is known to influence the fatty acid composition of coconut oil.

Among the vegetable oils, coconut oil is unique as it

contains maximum amount of saturated fatty acids. The main fatty acid is lauric acid which constitutes about 50 percent of the total fatty acids.

Coconut fatty acids are used in a wide variety of products, including Pharmaceuticals, Personal Health Care products and Soap industry. Availability of fatty acids from bio-based and renewable sources encourages industrial use of natural fatty acids as compared to their petroleum based and animal based counterparts. Increasing consumer awareness regarding the usage of products possessing nontoxic and environmentally sustainable ingredients has fueled the demand for coconut oil based natural fatty acids in the past few years.

According to the research report (Transparency Market Research (TMR)), the global palm oil based and coconut oil based natural fatty acid market was valued at USD 5.32 billion in 2014 and is anticipated to reach USD 7.98 billion by 2023, expanding at a CAGR of 4.6% between 2015 and 2023.

The global natural fatty acid market has witnessed significant growth in the past few years. Population growth coupled with rising per capita income resulted in increased consumption of personal care products and detergents in developing countries in the past few years. This, in turn, generated considerable demand for natural fatty acids in these industries, enabling it to be the largest end-user in 2014. Personal care is projected to be the fastest-growing end-user of the natural fatty acid market in the next few years. High awareness regarding personal well-being and hygiene maintenance has propelled the growth of the global personal care industry. Furthermore, several personal care products manufacturers are focused on using biocompatible and green materials to improve the bio safety of products. As a result, demand for natural fatty acids is expected to increase substantially in the personal care industry in future. Asia Pacific dominated the global market for coconut oil based natural fatty acids in 2014. The region is expected to continue witnessing a similar growth trend in the future period due to the rising demand from major end-user industries. Increase in purchasing power parity of consumers in developing countries of Asia Pacific is projected to boost the demand for natural fatty acids in the next few years. China is estimated to be the major consumer of natural fatty acids in 2023 followed by Rest of Asia Pacific. Europe was the second-largest consumer of natural fatty acids in 2014 followed by North America. Middle East & Africa and Latin America are anticipated to be the emerging markets for natural fatty acids in the next few years.

Coconut Fatty acid is the second largest coconut product imported into India, the first being copra expeller cake. In 2014-15 and 2015-16, India imported Rs. 73 Crores and 62 Crores worth coconut fatty acids respectively. Even though the imports declined in 2015-16, sizeable quantity of this product is continued to import into India. Around 91% of the import is from Malaysia and 6% from Indonesia. India doesn't have many coconut fatty acid manufacturing units. The high domestic price of coconut oil brought down the domestic production of fatty acids. Since the international price of coconut oil was ruling below the domestic price, until recently, the coconut fatty acid industry depended on import, rather than sourcing it domestically. India also exported coconut fatty acid on a meager quantity, export value being Rs. 0.11 Crore and 0.43 Crore in 2014-15 and 2015-16 respectively.

The average price of coconut fatty acid exported from India during 2015-16 was to the tune of Rs. 1, 27, 612 per MT while the price for the imported product was only Rs. 77,143 per MT. While the monthly average domestic price of coconut oil during April 2015 was 227 USD per quintal, the international price was only 108 USD per quintal. The difference in price is cited as the main reason attributed to increased imports.

The situation has changed now and there is ample opportunity to enhance the domestic production of coconut fatty acids as the competitive advantage in price continues. The average domestic weekly price of coconut oil in the last week of March 2016 was only 125 USD while the international price ruled at 162 USD per quintal. Efforts need to be initiated to tap full benefit out of this opportunity by increasing the domestic production. Since this product is having good demand in China, European Countries (Germany, France, UK, Italy), Brazil, GCC Countries and South Africa, potential for export are also high. As the technology is domestically available there is ample scope for entrepreneurs also to enter into this field. ■

Coconut research- achievements and future outlook

● **T.Rajamohan,** Former Professor, Department of Biochemistry, University of Kerala & Director, Coconut Research and Development Centre, Thiruvananthapuram

Coconut Research

Progress in any field can only occur through research. Conducting research is valuable for developing and promoting the body of knowledge and information that drives innovations and allows us to live healthier and longer. Scientific research is also important for dispelling the false claims of inaccurate research. Scientific research becomes socially meaningful when the work and its results reach the masses as practical solutions. There has been significant progress in coconut research in India in recent years. The Department of Biochemistry ,University of Kerala with its past 25 years of scientific activity, has contributed many results on the studies of coconut to the people. Since 1991, myself and my students in the Department carried out extensive studies on coconut products and its effect in health and disease. These studies generated immense data regarding the beneficial effects of coconut products namely coconut kernel ,coconut oil, virgin coconut oil, coconut water, coconut protein , coconut fiber, coconut haustorium and coconut inflorescence. The findings of the study on coconut oil had dispelled many fears about the use of coconut oil. This study has led to discussions and rethinking on the role of dietary oil on health.Studies conducted using tender coconut water was one of the significant works carried out by us, since it came at a time when the controversy over the health hazardous effects of synthetic drinks like coca cola was its peak in Kerla. The entire research on the health benefits of coconut products span over a period of 25 years has proved beneficial to coconut community in the world in general and Keralites in particular. This paper reviews briefly the major findings and the future outlook on coconut research.

Major findings

Hypolipidemic and Antiperoxidative effects

Research studies carried out by us in animals and humans indicate that coconut kernel play an important beneficial role in atherosclerosis through its effect on lipids and lipid peroxidation. Studies showed that coconut kernel decreases blood total cholesterol, LDL-Cholesterol and increases good HDL-Cholesterol and antioxidant status.In another study, coconut kernel showed significant hypolipidemic and antiperoxidative effect in experimental diabetic condition. Human studies clearly revealed that coconut oil does not increase blood total cholesterol or LDL- Cholesterol, but it increases good HDL- Cholesterol and decreases triglycerides. Studies showed that Virgin Coconut Oil (VCO)extracted from fresh coconut kernel is superior in hypolipidemic and antioxidant effects when compared to copra oil, olive oil and sunflower oil in rats. Studies found that Coconut kernel protein possess significant hypolipidemic effect and the major factor responsible for this effect is the high content of L- arginine (17.8%). Coconut kernel protein is able to reduce hyperlipidemia and antiperoxidative effect in diabetic rats. Also, studies revealed that coconut fiber isolated from coconut kernel has significant lipid lowering effect in the serum and tissues in experimental animals.

Cardio protective Property

Recent research revealed that coconut kernel protein (CKP) has a significant cardioprotective effect on isoproterenol induced myocardial infarction in rats. Pretreatment with CKP demonstrated reversal of focal lesions, fragmentation of muscle fibers and retrogressive lesions with hyaline necrosis in the isoproterenol treated group, confirming the cardioprotective activity of coconut protein. CKP in diet protects the heart by beneficially modulating endothelial nitric oxide synthase, tumor necrosis factor-alpha and nuclear factor- kappaB expressions in experimental myocardial infarction. The results suggest that dietary supplementation of CKP may have greater significance in reducing the extent of oxidative stress and inflammatory responses associated with myocardial infarction. Therefore, CKP may be

included as a protein addendum for the development of a cardiotonic nutraceutical or functional food.

Investigations using aqueous extract of Coconut Sprout (Haustorium) demonstrated significant protective effect against the occurance of myocardial infarction. Coconut sprout maintains cardiac integrity and alleviates oxidative stress in rats subjected to isoproterenol induced myocardial infarction. Activity of cardiac marker enzymes were increased in serum and decreased in the heart of isoproterenol treated rats, indicating cardiac damage. These changes were significantly reduced in haustorium pretreated rats. Histopathology of the heart of these rats showed almost normal tissue morphology. This observation indicates that coconut sprout protected the myocardium from isoproterenol- induced injury.

Studies clearly show that tender coconut water (TCW) possess significant cardio protective property and the effects were comparable to that of the novel cardio protective drug,Carvidilol. In another study, similar thrombolytic effects were observed when rats were treated with TCW and thrombolytic drug, streptokinase. Studies using TCW with lovastatin proved that TCW can lower cholesterol levels similar to lovastatin. Coconut water scavenges free radicals and decreases oxidative stress and thereby reduces the pathogenesis of myocardial infarction. It also inhibits platelet aggregation and adhesion by inhibiting fibrinogen and enhancing the release of anti-aggregatory nitric oxide which consequently decreases the thrombosis. Treatment with TCW seems to be more natural, less expensive and without side effects. Thus, it provides an accessible medicine source for the treatment of coronary heart disease. This result may provide some useful information for the further application of TCW as a cardiotonic medicinal food.

Studies demonstrate that Virgin Coconut Oil (VCO) possess cardio protective properties. It has beneficial effect in improving antioxidant status and preventing LDL oxidation. Since oxidised LDL Cholesterol is involved in arterial injury and the formation of fibrous plaque, protection by antioxidants has great potential in the prevention of coronary heart disease. VCO feeding decreases the apo B secretion and increases the apo A1 secretion. These results suggest that VCO beneficially regulates the apolipoprotein secretion in hepatocytes. In addition, it improves reverse cholesterol transport by upregulating the expression of LXR alpha and ABCA1. It decreases the VLDL- apo B secrection in hepatocytes by modulating the PPAR - alpha pathway and fatty acid synthesis by down regulating the mRNA expressions of SREBP in rat liver. Feeding VCO decreased the coagulation factors namely thromboxane B2, fibrin and fibrinogen levels in plasma. Decreased levels of coagulation factors observed in VCO fed rats reflects reduced thrombotic risk.

Antidiabetic effect

Research shows that coconut kernel protein (CKP) modulates diabetics in alloxan treated rats. Study clearly proved the beneficial effects of CKP in modulating the glucose and insulin levels as well as the key enzymes involved in carbohydrate metabolism in diabetic rats. CKP reversed the damage caused to pancreas by alloxan as evident from the histopathology. These effects of CKP may be due to the presence of the high amount of antioxidant Arginine, which is safe and natural Nitric Oxide donor capable of reversing the ill effects of diabetes. To our knowledge, this investigation is the first report to show that proteins from coconut kernel have antidiabetic effect.

Coconut water is mainly consumed in its early form and Mature coconut water (MCW) is usually discarded. Our studies clearly indicated that MCW possess antidiabetic property. The results indicated that diabetic animals treated with MCW had decreased blood glucose levels and increased insulin secretion.MCW significantly attenuated hyperglycemia, hyperlipidemia and oxidative stress in alloxan- induced diabetic rats, indicating the therapeutic potential of MCW. Histopathological analysis of pancreas revealed that treatment with MCW reduced the pancreatic damage induced by alloxan and stimulated beta-cell regeneration. The overall results show that MCW excerts significant antihyperglycemic potential and could be developed as a drug candidate or nutraceutical for the management of diabetes and associated complications.

Recent research revealed that young coconut inflorescence of coconut palm has significant protective effects against alloxan - induced pancreatic cytotoxicity and severe hyperglycemia in experimental animal. These beneficial effects were mediated by enhancing the peripheral utilization of glucose, correcting the impaired liver glycolysis and limiting gluconeogenic formation and also repairing and rejuvenating the residual beta-cell population. These effects may be due to the presence of phenolic acids, flavanoids, and other phytochemical constituents, which could act synergistically or independently in modulating the activities of glyconeogenic enzymes. The findings of the present study provide scientific validation for the use of coconut inflorescence as a promising factor in folk medicine in the treatment of diabetes.

Hepatoprotective and Renoprotective effects

Hepatoprotective effect of Tender Coconut Water were investigated in various experimental conditions using hepatotoxic agents such as Carbon tetra chloride, Ethanol, Insecticide (Carbaryl), Paracetamol and Cadmium. These studies revealed the hepatoprotective effect of TCW which is evident from

the histopathological studies of the liver which did not show any fatty infiltration or necrosis, as observed in hepatic damage induced rats. In another studies , rats induced kidney damage using various nephrotoxic agents such as Mercuric chloride,Chromium, Gentamycin and Cisplatin, TCW treatment caused beneficial effects in ameliorating the nephrotoxicity induced by the toxic agents.

Wound healing and Anti -ageing properties

Studies have found that Virgin Coconut Oil beneficially affects the wound environment and fastens the healing process. The results indicate a significant beneficial effect of VCO on intracellular matrix components and the antioxidant profile during cutaneous wound healing in animals treated. Histopathological study showed an increase in fibroblast proliferation and neovascularization in VCO- treated wounds compared to controls. The wound healing property of VCO may be due to its minor biologically active components and antimicrobial fatty acids. Animal study shows that consumption of Coconut Oil causes beneficial effect in ageing process. Progressive loss of mitochondrial function is one of the common events associated to ageing. Free radical damage has long been believed to be a risk factor for the degenerative process which accompany the ageing process. The results indicate that feeding coconut oil decreased the deleterious effects caused by the free radical mediated damage during ageing in heart mitochondria compared to those fed Sunflower Oil. The degradation of protein and DNA damage was found to decrease in aged rats fed coconut oil than those fed sunflower oil.

Spermatogenic effects

Our study indicated that coconut water ameliorates the reproductive toxicity caused by nicotine.Both Tender and Mature Coconut Water administration significantly improves sperm count, mortality, morphology and plasma testosterone in nicotine intoxicated rats. The findings indicated that coconut water supplementation improves epididymal spermatogenic cell density, sperm motility and morphology which were altered by nicotine. The activity of acid phosphatase and alkaline phosphatase was increased which indicates that treatment with coconut water provides significant protection of germinal epithelium from nicotine toxicity.Coconut Water also shows a significant increase in testosterone levels in nicotine treated rats. This study recommends further studies on pre- and post- treatement of coconut water in nocotine treated rats in order to extrapolate the results of the present study to human chronic smokers.

Anti-arthritic and Antitumor activities

Reserch studies have shown that tender coconut water exhibits anti-arthritic effect in Collagen- induced arthritis rats. The results indicate that administration of TCW in arthritis rats decreased the levels of Glycosaminoglycans and Glycoproteins in the plasma. There was significant decrease in the concentration of hydroxy proline in the urine in arthritis rats, while feeding with TCW decreased the urinary excretion of hydroxy proline. Activity of Lysosomal enzymes, Beta- Glucuronidase and Hexosaminidase were significantly increased in arthritis rats, while the activities of these enzymes were decreased by feeding TCW. The antiarthritic effects observed in this study include inhibition of joint inflammation and periarticular joint destruction and reduced inflammatory changes.

The antitumor effect of coconut water was studied using albino mice by subcutaneous injection of Daltons Lymphoma Ascites (DLA) Cells. The assessment of antitumor activity of tender coconut water was evaluated by measuring the activities of antioxidant enzymes, toxicity markers in serum and cancer marker enzymes. Oral administration of coconut water exhibited significant changes in the levels of antioxidant enzymes,toxicity markers and cancer marker enzymes such as Myloperoxidase and beta- D -Glucuronidase. Histopathological analysis of liver tissue from tumor -induced mice exhibited hepatocytes with enlarged nuclei, sinuloids dilated and focal inflammatory cell infiltration, while TCW treated group showed normal histology with mild Kupffer cell proliferation. The results of the study indicate that coconut water possess significant anticancer property

Antihypertensive properties

Extensive research carried out by us using tender coconut water showed that it is capable of preventing and ameliorating the hypertension induced by high fructose diet in rats. The altered activity of renin angiotensin in fructose fed rats is reversed by TCW and maintained the eletrolyte imbalance almost normal. Histopathological studies of kidney revealed that, high fructose diet produced glomerular tuft congestion , which was reverted by TCW treatment. This suggests that renal dysfunction could be ameliorated by treatment with TCW, which may be beneficial in the control of blood pressure. Also, the study shows that TCW treatment effectively reduced the oxidative stress in fructose fed hypertensive rats and improved the antioxidant status. Hypertension is a serious health condition. Reports suggest that individuals with high blood pressure are three to four times more likely to develop coronary heart disease and seven times more likely to develop a stroke. Several factors present in coconut water may contribute to reduction in blood pressure. Coconut water is rich source of minerals viz. Potassium, Calcium, Magnesium and Manganese. It also contains L-arginine ,Vit.C and Polyphenols. The superior effects of TCW in reducing the blood pressure are due to these biologically active components.The ability to bring

a favourable effect in blood pressure, renal function and the antioxidant activity makes TCW an ideal candidate for the treatment of clinical conditions associated with hypertension.

Future Outlook

From the studies carried out by us and others, it is well understood that ,coconut and its products possess high medicinal and therapeutic value. However, this information alone is not sufficient to provide evidence for safety and efficacy of a product and require additional investigations for exploring its benefits to mankind. A precise understanding of effective dose, safety and mechanism of action is required for the rationale use of coconut products in the treatment of human disease. It is expected that multiple components in coconut products lead to multiple effects on metabolic pathways and to involve multiple mechanisms affecting various aspects of chronic metabolic diseases.Hence, future studies must be pursued to identify and characterize various types of bioactive components present in coconut as well as to study the therapeutic potential and mechanism of action of those compounds in curing particular ailments.It is now necessary to follow up the traditional knowledge and the effects from animal studies to clinical outcomes for prevention and treatment of various diseases. Such studies must be undertaken by international cooperations. In addition, studies are warranted using underutilized factors for exploring the medicinal benefits. What is urgently required is the identification of projects that are of value to advance our knowledge on coconut. The widespread use of coconut products relies on intense research and development along with successful publicity programs to promote the benefits of these products.

The research findings presented in this article are generated from the research studies carried out by my students. 17 research students have completed their Ph.D based on studies on the health effects of coconut products from the University of Kerala. On this occasion, I express my sincere gratitude to all of them. ■

Obituary

Dr. Shyam Lal, Assistant Director, Coconut Development Board expired on 1st April 2016. He joined the Board on 31st December 1987 and became Assistant Director on 30th May 2008. CDB expresses deep condolence on his untimely demise.

Retirement

Shri. P Kasilingam retired from the service of Coconut Development Board on 31st April 2016 after rendering 28 years of service.

Research studies carried out on coconut

Name	Research Topic
Sindhu Rani J.A	Biochemical investigations on dietary fiber from coconut kernel
Padmakumaran Nair K. G	Biochemical studies on coconut protein
Suma K. S	Effects of diet and life style on the incidence of atherosclerosis – Study on coconut kernel and coconut oil.
Chithra K. R	Biochemical studies on unheated and heated coconut oil – Comparison with ground nut oil and sunflower oil
Mini S	Biochemical effects of coconut kernel protein on alcohol fed and isoproterenol treated rats
Gayathri N. S	Biochemical effects of coconut oil supplemented with rice bran oil
Anurag P	Biochemical effects of Tender coconut water in experimental myocardial infarction
Sandhya V. G	Biochemical investigations on coconut water in cholesterol fed and nicotine treated rats
Nevin K. G	Biochemical studies on coconut oil extracted from coconut kernel by wet process
Bhagya D	Investigations on Tender coconut water in hypertensive rats
Salil G	Biochemical investigations on coconut protein in normal and diabetic rats
Chinu Chacko	Study on the role of coconut oil subjected to thermal stress in experimental atherosclerosis
Preetha P P	Biochemical studies on coconut water in experimental diabetes
Shalini A Nair	Influence of coconut oil on oxidative stress and antioxidant status in ageing rats
Arunima S	Biochemical evaluation of Virgin coconut oil in experimental animals
Renjith R S	Studies on immature inflorescence of cocos nucifera (L) in experimental diabetes mellitus
Chikku A M	Effects of coconut sprout (cotyledon) on isoproterenol induced myocardial infarction

Virgin coconut oil - major source of life saving drugs

• **Dr.P K Krishnan Namboori, Sanjay Kumar P** and **Karthikeyan S,**
Computational Chemistry Group, Amrita School of Engineering,
AMRITA Vishwa Vidyapeetham University, Coimbatore.

Coconut has become an essential and inevitable component of every part of our life due to its wide range of applications and benefits. Besides using it as a food additive in different forms such as coconut milk, coconut oil, coconut cake, copra, palm sugar and so on, a number of other applications of coconut and its products have recently been excavated. The extensive usage of coconut is found to be helpful for the people living in the tropics in controlling heart disease, cancer, diabetes, Alzheimer's, arthritis etc. Medicinal value of coconut and its products has been already accepted in many cultures throughout the world. Coconut oil is given to patients and infants to improve digestion when they are unable to digest other fats. Coconut oil has properties to enhance immunity to body by checking the external infections and diseases. It is considered as 'a low calory fat' as it promotes weight loss. The coconut oil primarily consists of saturated fats of plant origin which is different from the saturated fats of meat or other animal origins. The fatty acids of plant origin are medium chain fatty acids while that of meat or animal origin are long chain fatty acids which can be harmful if included in diet beyond certain limit [1].

Virgin Coconut oil or VCO is prepared with zero or nil adulteration and usage of heat. The virgin coconut oil is very close to its natural form, when compared with normal commercially available coconut oil, where a lot of pre-processing including thermal treatment are involved during its manufacture. Both Virgin and normal coconut oil contains almost all medium chain fatty acids. However VCO is enriched with most of the phytochemicals present in coconut.

These phytochemicals include phytosterols, polyphenols and different kinds of antioxidants. This results in specific unique biological activities of VCO making it a promising source of drugs for a number of diseases. Intake of VCO stabilizes the blood cholesterol level between 170-200 ml/dl. **It is seen promoting the conversion of cholesterol to pregnenolone used for the production of adrenal and sex hormones. It is also having a regulatory effect by increasing the level of cholesterol when needed [2]**. A recent study in rats proved that the consumption of VCO can be beneficial in conditions such as insulin resistance. A fructose rich diet in rats was compensated with VCO instead of normal coconut oil and the results showed only a 17 % increase in blood glucose level for the rats fed with VCO when compared to 46% for the rats fed with normal coconut oil. This proves the anti-diabetic nutraceutical properties of VCO [3]. Virgin coconut oil is found to be a neuroregenerative agent in Alzheimer's disease (AD) and other Fronto Temporal Dementias (FTDs). A case study conducted in USA by Dr. Mary Newport on her husband who had late onset AD showed signs of improvement within a short span of time [4].In a very recent clinical trial conducted in Spain involving VCO for AD patients give promising results. The study was conducted using the patients as a group of controls and intervention groups. The intervention group was given 40 ml/day of extra virgin coconut oil. The patients on a VCO diet showed significant improvement in test score of MMSE (Mini-Mental State Examination) which again proves the importance of VCO in treating AD [5].

The phytochemicals present in VCO and their major medicinal properties are listed in Table.1 . These phytochemicals have been tested for their response towards various diseases like HIV, Cancer, cardiovascular disease, skin disease, neurodegenerative diseases etc.

Table 1. Major phytochemicals present in VCO and their medicinal properties

Sl. No	Phyto Chemicals	Medicinal Properies
1	6-BENZYLAMINO-PURINE	Anti-HIV,Anti-Cardiac diseases,Skin,-Care,Anti-Viral,Neuroregenaration,Anti-Cancer
2	CAPRYLIC-ACID	Anti-HIV,Anti-Cardiac diseases,AntiDiabetic,Anti-Viral,Neuroregenaration,Anti-Cancer
3	CIS-ZEATINE	Anti-Viral,Neuroregenaration,Anti-Cancer
4	DIPHENYL UREA	Anti-Cardiac diseases,SkinCare,Anti-Viral,Neuroregenaration,Anti-Cancer
5	KINETIN	Anti-Viral,Neuroregenaration,Anti-Cancer
6	LAURIC-ACID	Anti-HIV,Anti-Cardiac diseases,Anti-Diabetic,SkinCare,Anti-Viral,Neuroregenaration,Anti-Cancer
7	LINOLEIC-ACID	Anti-HIV,Anti-Cardiacdiseases,Anti-Diabetic,SkinCare,Anti-Viral,Neuroregenaration,Anti-Cancer
8	MYRISTIC-ACID	Anti-HIV,Anti-Cardiacdiseases,Anti-Diabetic,SkinCare,Anti-Viral,Neuroregenaration,Anti-Cancer
9	NIACINE	Anti-Cardiacdiseases,Anti-Viral,Neuroregenaration,Anti-Cancer
10	OLEIC-ACID	Anti-HIV,Anti-Cardiacdiseases,Anti-Diabetic,SkinCare,Anti-Viral,Neuroregenaration,Anti-Cancer
11	PALMITIC-ACID	Anti- HIV, Anti-Cardiac, Anti-diabetic, Anti-Thyroidism, Anti-Viral, Anti Fungal, Anti-inflamatory, Neuroregenerative, Anticancer
12	PHYTOSTEROLS	Anti-Viral, Anti-Fungal, Anti-inflamatory, Neuroregenerative, Anticancer
13	SQUALENE	Anti-Cardiac, Anti-Bacterial, Anti-Viral, Anti-inflamatory, Neuroregenerative, Anticancer
14	STEARIC-ACID	Anti-HIV, Anti-Cardiac, Anti-Thyrodism,Anti-Viral, Anti-inflamatory, Neuroregenerative, Anticancer
15	TRIDECANOIC-ACID	Anti- HIV, Anti-Cardiac, Anti-diabetic, Anti-Thyroidism, Anti-Viral, Anti-inflamatory, Neuroregenerative, Anticancer
16	UNDECANOIC-ACID	Anti-Cardiac, Anti-diabetic, Anti-Thyroidism, Anti-Viral, Anti Fungal, Anti-inflamatory, Neuroregenerative, Anticancer
17	VIT E	Anti-Diabetic, Anti-Fungal, Ani-Viral, Neuroregenerative, Anticancer

The results are highly supportive and promising.

Anti-HIV properties

The VCO phytochemicals showing Anti-HIV properties include, 6-Benzylamino purine, Caprylic Acid, Lauric Acid, Myristic Acid, Oleic Acid, Palmitic Acid, Stearic Acid and Tridecanoic Acid. The HIV spread in our body depends upon the attachment of viral protein envelop gp120 to a well defined locus of CD4 protein of lymphocytes [6]. Among the phytochemicals 6-Benzylaminopurin can be considered as an effective 'HIV attachment inhibitor'.

The Reverse transcriptase enzyme in HIV-1 and HIV-2 helps in the conversion of single stranded RNA genome of the virus into double stranded DNA which gets integrated into the host DNA. Most of the anti-HIV drugs are designed to inhibit this reverse transcriptase activity [7]. The VCO phytochemicals like Caprylic Acid, Lauric Acid, Myristic Acid, Oleic Acid, Linoleic Acid, Palmitic Acid, Stearic Acid and Tridecanoic Acid have been reported as keeping HIV-2 reverse transcriptase inhibitor activity.

Anti-Cardiovascular disease properties

The VCO phytochemcicals showing anti-cardiovascular disease properties include, Linoleic Acid, Oleic Acid, Lauric Acid, Myristic Acid, 6-Benzylaminopurine, Caprylic Acid, Niacine, Diphenyl Urea, Palmitic Acid, Squalene, Stearic Acid, Undacanoic Acid and Tridecanoic acid.

The two anti-cardiovascular disease properties shown by these phytochemicals include cardioprotectant and cardiovascular analeptic properties. Cardio protective properties of these phytochemicals are mainly based on their antioxidant activities. All phytochemicals listed have this protective activity.

The phytochemicals having cardio analeptic properties include Caprylic Acid, Niacine, Diphenyl Urea, Myristic Acid, Palmitic Acid, Squalene, Stearic Acid, Undacanoic Acid and Tridecanoic acid.

Anti-Diabetic Properties

The VCO phytochemicals having anti-diabetic properties include Linoleic Acid, Niacine, CaprylicAcid , Lauric Acid , Myristic Acid, Oleic Acid, Palmitic Acid, Undacanoic Acid, Tridecanoic Acid and Vitamin E. These phytochemicals are also antidiabetic symptomatic improving the conditions of the patients suffering from diabetes related symptoms like diabetic neuropathy, hyper/hypoglycemia, coronary heart diseases etc.

Anti-Thyroidism related Properties

There are certain VCO phytochemicals which can improve on conditions such as hyper/hypo thyroidism. This includes Palmitic Acid, Stearic Acid, Undecanoic Acid, Oleic Acid and Tridecanoic Acid. In a normal process, Thyroxine (T4) is converted to an active form triiodo-thyronine (T3) after deiodination.

The presence of extra thyroidal Thyroxin-5-deiodonase from liver and kidney can generate a large number of circulating T3 which can cause hyperthyroidism [8]. The above mentioned VCO phytochemicals have Thyroxine 5-deiodinase inhibitor activity which can improve the conditions of hyperthyroidism.

Anti-Viral, Bacterial, Fungal Properties

The VCO phytochemicals have been identified as associated with a lot of anti-viral, anti-fungal and anti-bacterial properties. Most of the antiviral properties are listed in Table 2. The phytochemicals with anti-fungal activity include Linoleic-Acid, Lauric-Acid, Myristic-Acid, Oleic-Acid. The compounds with antibacterial activities include Linoleic-Acid , Oleic-Acid , Niacine and Sqalene.

Anti-Inflammatory Properties

The VCO phytochemicals having anti- inflammatory activities include Palmitic Acid, Phytosterols, Squalene, Stearic acid, Undecanoic acid, Oleic Acid. The two major inflammatory diseases associated with intestine are Crohn's disease (CD) and ulcerative colitis (UC). A dietary supplement with VCO can impart anti-inflammatory activities.

Neuroregenerative Properties

Our own research in VCO phytochemicals has proven that they have neuroregenerative properties. The phytochemicals with neuroregenerative activities include,6-Benzylaminopurine, Caprylic Acid, Cis-Zeatine, Diphenyl Urea, Kinetin, Lauric Acid, Linoleic Acid, Myristic Acid, Niacine, Oleic-Acid Palmitic Acid, Phytosterols, Squalene, Stearic Acid, Tridecanoic acid, Undecanoic Acid, Vitamin E and Oleic Acid. They are found to be a Beta-adrenergic receptor kinase inhibitor (GRK2). The AD pathogenesis includes the accumulation of A$\\beta$ in the nerve cells and as a result, reduced cell membrane and elevated levels of Beta adrenergic receptor kinases. They are found to desensitize the activated G protein-coupled receptor for signal transduction. Elevated levels of beta adrenergic receptor kinases leads into decrease in the level of signal transductions resulting in neurodegeneration [9]. Since VCO phytochemicals are found to have an inhibitory effect on GRK2, this can lead to neuroregeneration.

Anti-Cancer Properties

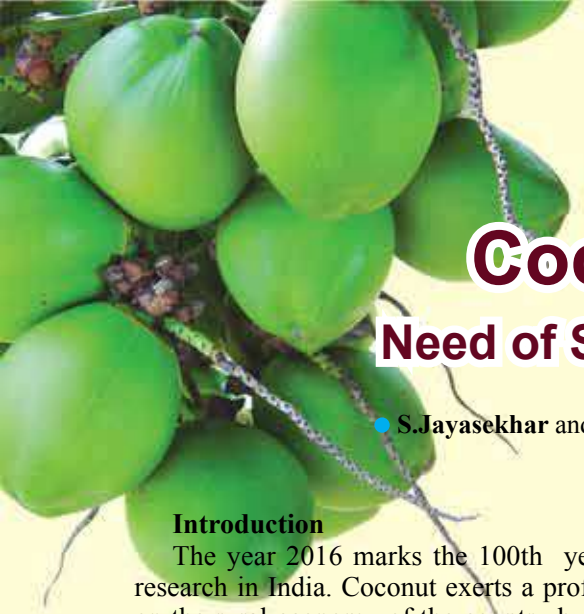
All 17 VCO phytochemicals, 6-Benzylaminopurine, Caprylic Acid, Cis-Zeatine, Diphenyl Urea, Kinetin, Lauric Acid, Linoleic Acid, Myristic Acid, Niacine, Oleic-Acid Palmitic Acid, Phytosterols, Squalene, Stearic Acid, Tridecanoic acid, Undecanoic Acid, Vitamin E and Oleic Acid listed here are found to have various anti-cancer properties. Out of anticancer activities of VCO, the major mechanisms involved are Cyclic AMP agonistic and Fibroblast growth factor agonistic properties. **Cyclic AMP is a messenger involved in various regulation mechanisms in our cells. These cAMPs are found to bind with cAMP activated protein kinases (PKA), supporting the progression of tumors and leading into cancer [10]. VCO phytochemicals can act as an agonist to cAMPs and deactivate PKA, there by acting as an Anti-Cancer agent.**

Table 2 Major biological activities of constituents present in VCO

Activity	Phytochemicals
Antiviral (Adenovirus)	Caprylic-Acid , Lauric-Acid , Myristic-Acid, Oleic-Acid, Niacine, Linoleic-Acid ,
	Diphenyl Urea, Cis-Zeatine,
Antiviral (CMV)	Caprylic-Acid , Lauric-Acid , Myristic-Acid,
	Oleic-Acid, Niacine, Linoleic-Acid
Antiviral (Hepatitis B)	Caprylic-Acid , Lauric-Acid , Myristic-Acid
Antiviral (Herpes)	Cis-Zeatine, Oleic-Acid , Linoleic-Acid ,
	Caprylic-Acid , Lauric-Acid , Myristic-Acid,
	6-Benzylaminopurine, Kinetin
Antiviral (Influenza)	Oleic Acid, Linoleic-Acid , Caprylic-Acid, Lauric-Acid
	Myristic-Acid, Diphenyl Urea, Niacine
Antiviral (Picorna-virus)	DiphenylUrea,Caprylic-Acid, Lauric-Acid,
	Myristic-Acid, Oleic-Acid , Linoleic-Acid ,
	Niacine,6-Benzylaminopurine, Cis-Zeatine,
	Kinetin

One of the classes of cellular functional regulators includes 'fibroblast growth factor regulators' (FGFs). These molecules help in cellular proliferation, differentiation and migration. Lately FGF signaling has been targeted in checking cancer cell proliferation and differentiation [11]. VCO phytochemicals keep FGF agonist property arresting the cancer cell proliferation.

The VCO is a major source of drugs for a number of diseases. Much research is going on in this direction to identify the phytochemicals responsible for different biological activities. Even the metabolites derived from VCO could be a reasonable source of potential drugs. ■



Coconut Research in India

Need of Stakeholders' Synergy for Prosperity

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Introduction

The year 2016 marks the 100th years of coconut research in India. Coconut exerts a profound influence on the rural economy of the country by supporting the livelihood of ten million people in the country. It also contributes to the national agrarian economy, with an annual contribution to the tune of Rs 9000 crores to the GDP and foreign exchange earnings of about Rs 1200 crores, besides supporting the subsidiary industrial development. However, of late coconut is faced with unprecedented crises on account of various macro and micro level factors. The productivity of the crop is constrained by the low input use efficiency in conjunction with other biotic and abiotic stresses which are priority areas of research. The mechanization also deserve adequate importance, considering the scarcity of skilled labour. Above all, the most important facet is value addition, which should be strengthened to mitigate the issue of low profitability of the sector. The post World Trade Agreement (WTA) and ASEAN Treaty regime witnessed integration of plantation economies across the globe that resulted in fierce competition among producing countries. The relevance of a retrospection and introspection of 100 years of research in the coconut sector arises exactly in this context, wherein the institutions strive for technology generation and dissemination to address the challenges and to convert the weaknesses to opportunities, in a concerted and synergized fashion.

Coconut: National scenario

India has produced 20440 million nuts in the year 2015 from an area of 1.97 million ha with a productivity of 10345 nuts per hectare (Table 1). It is predominantly cultivated in small and marginal holdings. Most of these holdings neither provide gainful employment opportunities for the family labour throughout the year nor generate sufficient income to meet the family requirement. Presently coconut growers are more exposed to economic risks and uncertainties owing to the high degree of price fluctuations. In this context it is needless to emphasize the importance of crop diversification in coconut gardens. For brightening the future prospects of a sustainable coconut sector, it is imperative to delink the sector from the dependency on coconut oil and enhance the production of diversified value added products.

Table 1. Coconut-National scenario

State	Area (000 ha)	Production (mn. nuts)	Productivity (nuts/ha)
Andhra Pradesh	106	1464	13808
Karnataka	515	5141	9982
Kerala	650	4897	7535
Tamil Nadu	465	6917	14873
Other States	240	2021	7295
India	1976	20440	10345

Source: CDB, 2015

Research contributions over a century

It is unique that the coconut sector has been evolved through imbibing the scientific excellence for the past 100 years. The country has rich genetic resources to provide breeders with required genetic stock to tackle future challenges. It maintains the largest collection of coconut germplasm (438 accessions). It is noteworthy that an International Coconut Gene bank for South Asia (ICG-SA) has been established in the country under a tripartite agreement among ICAR-FAO-ITPGRFA. We have a National Coconut Gene Bank (NCGB) that serves as the National Active Germplasm Site (NAGS) for coconut. The focused research efforts to improve productivity and overall profitability to the farmers resulted in the development and release of high yielding varieties and hybrids. Eighteen improved high yielding varieties including twelve selections and six hybrids were released. There is tremendous potential for the released varieties as they are capable of yielding two to six times more than the average yield in different growing regions. The coconut based cropping system (CBCS), and coconut based mixed farming system (CMFS) categorically proved the advantages of the system

approach. The CBCS using multi species cropping of coconut with pepper, banana, nutmeg, pineapple, ginger, turmeric and elephant foot yam generated a net income of Rs 3, 62,595 per ha, which is 150% higher than that of coconut monocrop (Rs 1,41,505), while the CMFS wherein the components are coconut, pepper, banana, crossbred cows, poultry birds, goat, and pisciculture generated a net return of Rs. 5,50,214 which is 288% higher than that of coconut monocrop.

Plant growth promoting rhizobacteria (PGPR) based product-Kera Probio has been released for clean and green cultivation of coconut to maintain sustainability. Integrated disease management strategies developed for root (wilt) and leaf rot affected coconut gardens could increase yield by 25-83% depending on severity of the disease. The coconut climbing model developed with the safety attachment has become an effective solution since it could be operated even by women with proper training. This gives much required confidence to the climbers especially the beginners. In an effort towards value addition, Institutes have developed complete package of practices for the production of virgin coconut oil, coconut chips, coconut honey, jaggery and sugar. Besides, the Institutes developed 'Coco-sap Chiller' for collecting fresh, hygienic and unfermented coconut inflorescence sap called 'neera'. The research system has been producing quality planting materials in coconut for distribution to farmers. Seed gardens of improved varieties have been established at the Institute's level as well as in farmer's garden to augment planting material production.

It is worthwhile to note that coconut based microenterprises run by women SHGs have increased their income by 3-5 times compared to their previous income from copra, securing a steady source of additional income. Equally important, the intervention provided employment opportunities to formerly unemployed and under employed rural women resulting in enhanced self esteem, and economic & social empowerment. It is striking that, trained women serve as 'skilled coconut pollinators' for coconut hybrid production. Coconut climbing and pollination was men's territory so far, since the practice involved considerable drudgery and the risk. Women have learnt the steps in coconut pollination with ease a carry out the work with confidence.

In nutshell, the existing design of the research systems of coconut is well evolved and could be categorized under the sectoral system of innovation frame. The system is essentially a complex one with multitude of inter linkages at various levels of activities. In addition to this, system is also benefited by the coordination and replication functions provided by the All India Coordinated Research (AICRP) on palms. In the recent period there is a proactive movement to ensure maximum possible participation of the stake holders' through the formation of strategic research clusters. The system has evolved not only as a research hub meant for the productivity growth of coconut, but also as a crucial facilitator of the entire process of technology generation to the technology refinement options pertaining to coconut sector.

However, the changing scenario of coconut sector warrants innovative strategies and approaches to address new challenges and sustain accelerated growth along with competitiveness and sustainability. In the present global scenario, it is evident that coconut requires to be promoted as a food crop for nutrition, health care and environmental services to safeguard the livelihood of millions of people. It is necessary to rope in global partners for collaborative programmes to address the long standing and complex problems in the sector. Efforts have to be intensified to gainfully utilize new frontiers of science and technology, which would include an understanding of structural and functional genomics, long term conservation of genetic resources through cryopreservation, development of varieties for biotic/abiotic stress tolerance and higher resource use efficiency, use of nanotechnology in disease diagnostics and targeted delivery of biomolecules etc.

Impediments in the trade spectrum

The significance of analyzing coconut sector in India in the light of recent policy issues, especially the ASEAN-India Free Trade Agreement (AIFTA) emerges in the context of commodity crisis. The likely impact of AIFTA could not be undermined for three reasons. Firstly, the present context should be seen as a continuation of evolving trade liberalization regime and the effects of such a regime on plantation sector. Secondly, although coconut and coconut oil is put under the negative list, the tariff reduction in palm oil , which is a close substitute of coconut, would turn up detrimental in the near future (Table 2). The surging palm oil imports in the recent years are noteworthy and substantiate this argument. Thirdly, the agreement is evolving one and the tariff rates fixed are ceiling rates (the maximum level to which tariff can be fixed), thus providing adequate flexibility to fix the tariff rates to lower levels. Although coconut and coconut oil are in exclusion list of AIFTA, there is a general commitment under AIFTA to review the exclusion list every year with a view to improve the market access. Obviously, there will be pressure to reduce the number of tariff lines kept in the exclusion list. Therefore, there always exists a threat in the case of coconut, seeing that, the existing price difference may facilitate the cheap imports in case of coconut removed from the exclusion list.

Table 2. Tariff reduction schedule: Special products				
Tariff line	Base rate	2010	2015	2019
Crude palm oil	80	76	56	37.5
Refined palm oil	90	86	66	45
Coffee	100	95	70	45
Tea	100	95	70	45
Pepper	70	68	58	50

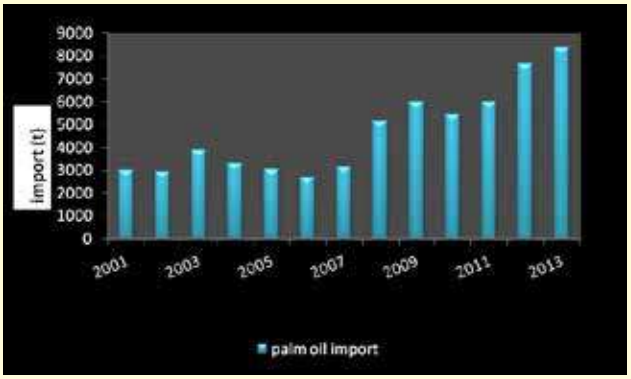
Regional trade agreements are becoming inevitable in the growth path of trade liberalization and globalization. The most important aspect in the evolving trade agreements regime is to appropriately reflect the sectoral interests/issues in the national agenda so that the sectoral apprehensions are well represented in the regional/ free trade agreements. In order to materialize this, in-depth sectoral studies in collaborative mode on various facets of coconut economy in India has to be conducted and well chalked out sectoral policy documents should be brought out. It is also necessary to find out the leverage points of the coconut sector wherein we can gain the competitive advantage vis-a vis the other competing countries in the international arena.

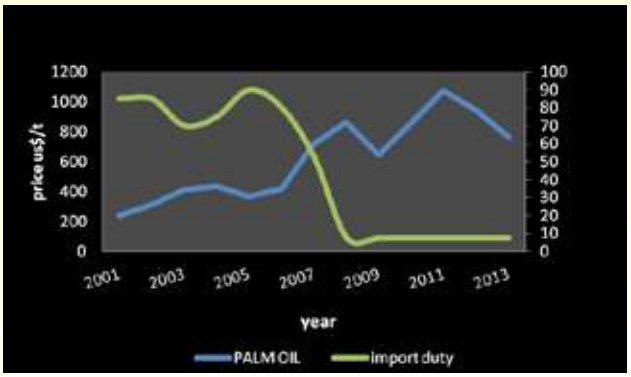
The import duties on edible oils have moved basically in counter-cyclical nature to the level of edible oil prices in global markets. This is a rational policy choice which is required to stabilize edible oil prices in the domestic market. Figure 1 shows the trend in international palm oil prices and correlates it with the Indian import duty structure for palm oil. In 2007-08, the international prices of palm oil were on an uptrend and therefore, the import duties on crude palm oil (CPO) and refined palm oil were reduced drastically to nil and 7.5 percent, respectively wef 1st April, 2008 to moderate the domestic prices of edible oils. But since 2012, the palm oil prices have been declining and the import duty still remains at a low level. In view of fall in international prices of palm oil, the import duty on crude palm oil was increased to 2.5 percent but remains the same for refined palm oil.

The import duty for palm oil has to be dynamically adjusted to its international prices as palm oil prices acts as an anchor to all edible oil prices. A bearish trend in palm oil prices exerts downward pressure on prices of all edible oils with an adverse effect on domestic production and further rise in palm oil imports. Therefore, there is an urgent need to re-calibrate the import duty structure.

For better trade relations among the APCC countries it is imperative to form a regional coconut trade agreement among the APCC countries. The modalities of such a commodity specific trade agreement should be worked out with utmost care wherein we should end up in a win-win situation. In this respect we need to thoroughly analyze the existing tariff structure of each APCC countries and an unbiased tariff reduction schedule should be proposed. It is also important to consider the existing tariff structures of close substitutes/competing products of each countries and there by arriving at a consensus.

Figure 1. Palm oil imports and tariff structure





The nuances of existing innovation system

We have seen that the current innovation system of coconuts in India has huge strengths on the research front of coconut, but the lack of price stability, inadequate price support mechanism and marketing facilitation are the factors detrimental to the functioning of coconut value chain in the state. The innovation system for coconuts in India is unique wherein several governmental agencies/ institutes undertake the research and development for the commodity, with evidently lacking collaborative efforts. Eight components delineated in the sectoral innovation system of coconut are: (i) In the research front, Central Plantation Crops Research Institute (CPCRI), (ii) at the policy level, Coconut Development Board (CDB), (iii) for marketing aspects of coconuts, National Agricultural Cooperative Marketing Federation of India Ltd (NAFED), (iv) the unorganized producers with small

and marginal holdings constitute the fourth component of the coconut innovation system, (v) the evolving Farmer Producer Organizations (FPOs) in the forms of coconut producer's societies, federations and companies, (vi) the intermediaries in the coconut sector operate in a very large grey area forming syndicates, lobbies and also practice the copra/coconut oil hoarding which causes continuous price fluctuations in the market (vii) the state departments of agriculture/horticulture and who are entrusted with the field level transfer of technologies. Besides these seven components, the most important but ironically the most under rated component is the local self governments which systematically operate at the grass root level. The lack of effective group coherence among different stakeholders is still remaining as a problematic facet in the sector. Though, there is huge potential for the collaborative synergy of these different Institutions, as a matter of fact, instead of the convergence, the redundancy of efforts is much more prominent in the sectoral front. It is high time that, especially in the historic centenary year of coconut research, we the researchers, developmental agencies, farmers and all other sectoral agencies/actors come together on the same platform to channelize our strengths, skills, experience and passion towards achieving a common goal-a rejuvenated, vibrant and sustaining coconut sector.

The forms of coordinations among different stakeholders operating to shape up the coconut innovation system are depicted in Figure 2. Here we have categorized the forms of coordination into four categories which are represented by different patterns of lines in the Figure. The forms of coordinations vary from non-significant to strong coordinations. It is interesting to observe that the strong coordination among the important stakeholders

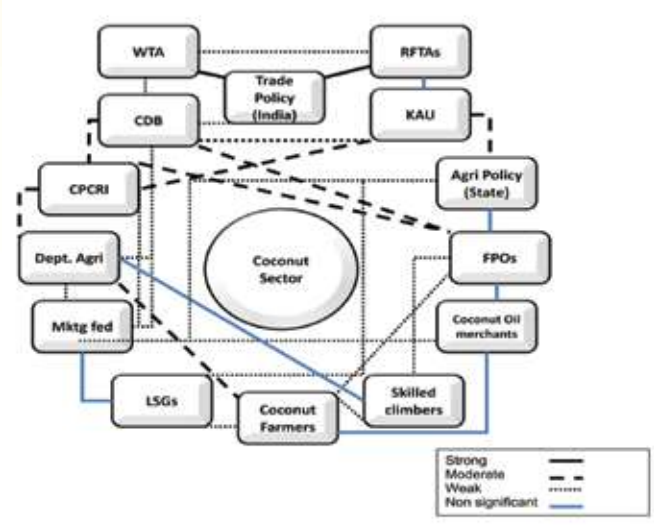


Figure2. Forms of coordinations in coconut innovation system

are lacking in the system. In general the sectoral system is dominated by week forms of coordinations, and in this scenario, it is highly imperative to identify the pulse points for corrections in the sectoral innovation system of coconut in India.

At present, the ambience of coconut sector in the domestic arena is positive wherein the horizontal node of the value chain aspect is strengthened by the formation of Coconut Producer's Society at the grass root level to Coconut Producer's Company at the highest level, thereby provides an excellent auxiliary support for the ambitious export orientation programmes. The strategic positioning of developmental and research support (CDB, CPCRI, KAU, NAFED) is another very important factor which will provide the much needed impetus for the sectoral development. Moreover, Indian export sector has become vibrant with very high growth rate since CDB has upgraded to the status of Export Promotion Council (EPC). The initiative taken by government in promoting neera in 2013-14 is also expected to revive coconut economy of the country.

In the future, it is envisaged that globally well connected and highly interlinked commodity chains will evolve, requiring a reorientation of the scope of the research and developmental Institutes to accommodate the restructured commodity chains and changing concept of commodity markets. The Institutes should take a lead role to re-engineer and revitalize the coconut sector in the country by providing adequate emphasis on product diversification and creation of neo-market platform to promote coconut as an organic health drink with Good Management Practices (GMP), Good Agricultural Practices (GAP) and Hazard Analysis and Critical Control Points (HACCP). Institutes should facilitate co-creative, innovative, vibrant social enterprises which will enable to pass on the value creation in coconut sector to farmers in an appropriate manner which reduces the social disparity. With the growing realization of lesser profitability in small farm holdings, producers and farmers should be encouraged to get together and form into small cooperatives or crop based organizations to develop and utilize community facilities for farm operations, post harvest processing and marketing to economize on production as well as marketing costs. Further, research orientation will lead to an increase in the number of economically viable coconut farms of different sizes and increase in the number of processing enterprises. As the technologies are adopted only when profitable, policy interventions in market and regulation of trade tariffs to the benefit of the industry to compete with global players are the way forward. To encourage investments in coconut sector, the government, as policy a policy matters must consider coconut as a priority crop in its national agricultural development agenda. ■

Novel tissue culture techniques for propagation of elite coconut cultivars

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Coconut is grown widely across 17 states and 3 union territories in India. Coconut cultivation is facing various problems such as diseases, pests and senility of existing palms. Predominantly cross-fertilized nature of coconut results in enormous variability in the seedling progenies, leading to dearth of quality planting materials. Though India is the first country to evolve a commercial hybrid in coconut, the current production of quality planting materials meets only 20 percent of the annual requirement. The demand in quality seedlings has drastically increased and to meet this gap, novel strategies have to be taken up to produce quality planting materials.

Seed propagation is the only viable method of producing planting materials in coconut palms. Coconut is long lived and has a very long juvenile phase. Hence crop improvement is a difficult and long-term process. Vegetative propagation, employing tissue culture techniques, offers a means of cloning improved planting material within a short period. Coconut tissue culture has a long history dating back to the 1950s. The *in vitro* technique for mass production of clonal palms is most advanced with date palm and oil palm. However, coconut palm has remained largely recalcitrant as far as tissue culture is concerned. A few accomplishments have been made in the recent past and plant regeneration was reported from a range of explants viz., immature embryo, tender leaf, mature embryos, plumules, unfertilized ovaries and inflorescences.

Tissue culture Research in Coconut

Various countries have been into tissue culture research in coconut. A research study on coconut tissue culture for clonal propagation and safe germplasm exchange was designed by International Coconut Genetic Resources Network (COGENT) and International Coconut Genebanks (ICGs). The research provided a series of new tissue-culture techniques that

could be used for the safe collection, conservation and utilisation (replanting programs) of the region's unique coconut genetic resources by Indonesia, Vietnam, Papua New Guinea and Philippines. The study was undertaken to develop an improved method of embryo culture for collection, national or international exchange and routine revival after cryopreservation of elite coconut germplasm. As a result, a highly efficient embryo culture technique in coconut was developed from the pre-project success rate of 20% to 80% in field level. The same technique resulted in shortened time by about 4 months (from 12 to 8 months), thus reducing certain inputs and making the process more cost-effective.

Similarly a research was undertaken by Republic of Philippines on Somatic embryogenesis, a promising technology to mass propagate coconut funded by Department of Science and Technology- Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD). The researchers reported that among the explants tested, the plumules are most responsive for in vitro manipulation for the micropropagation of coconut.

Research at TNAU and its progress

The challenging project on Standardization of *in vitro* culture techniques through somatic embryogenesis for propagation of elite coconut cultivars is undertaken by the Department of Plant Biotechnology, Tamil Nadu Agricultural University, Coimbatore, with financial assistance from Coconut Development Board, India during 2014. The progress of the projects is detailed below:

Mature embryos and plumules of West Coast Tall (WCT), Chowghat Orange Dwarf (COD) and Malayan Green Dwarf (MGD) were used in the study. Euegens Y3 media containing Benzyl Amino Purine (BAP) and

Coconut water was used for mature embryo culture. For Plumule culture Euegens Y3 media with different combinations and concentrations of hormones were used. Hormones like 2, 4, D, BAP, Kinetin, Zeatin and Thidiazuron were used. Mature embryos cultured in Y3 media supplemented with 300 µM BAP produced plantlets (120-140 days) in WCT, COD and MGD. Plumules cultured in Y3 media containing lower concentrations of 2, 4, D (25µM to 200 µM) exhibited organogenesis while the higher concentrations of 2,4, D (600µM to 2mM) were found to be toxic to the explants.

Somatic embryogenesis

Plumules cultured in Y3 supplemented with 2,4, D and BAP produced callus. These calli produced primary somatic embryos in 80-120 days after inoculation. Plant regeneration and induction of secondary somatic embryos were attempted by sub culturing. For regeneration Y3 media containing BAP and Zeatin were used. Shoot like structures and roots were produced in media containing Zeatin. Secondary somatic embryos were produced in Y3 media containing 2,4, D and BAP. Earlier research has proved the possibility of producing 35,000- 50,000-fold increased somatic embryo formation through secondary somatic embryogenesis and embryogenic calli multiplication using plumule explants.

Conclusion

The research results showed that the response of plumule explants to *in vitro* culture conditions in terms of callus formation and embryogenic capacity is the best among other explants. Standardization of the mass regeneration protocol from the somatic embryos will lead to mass production of elite disease-resistant planting materials. Coconut somatic embryogenesis is a promising technology that could be employed for commercial production of quality planting materials. ■

Road map to future research in coconut

Amit Ghosh, Assistant Professor, Department of Physiology, All India Institute of Medical Sciences and **Sumana Chaudhuri,** Research Scholar, School of Management, KIIT University, Bhubaneswar, Odisha.

Agriculture accounts for 12% of Indian GDP. Almost half of the workforce and more than 2/3rd of the population depend on agriculture. Agribusiness is constantly facing changing business environment due to globalization, advances in technologies, changing policies and environment and emergence of modern value added products. Coconut based agribusiness is also facing the same business environment. So the need of the hour is to develop a model for sustainable coconut based agribusiness. India is the largest coconut producing country in the world. India's strong base in agriculture science, food processing technologies and medical research can be instrumental for the upsurge of coconut based agribusiness in the country.

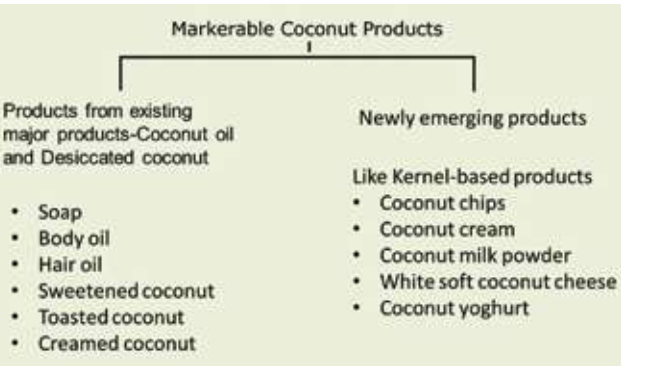
The Market

Marketable coconut product from coconut oil and desiccated coconut are produced by different countries. Coconut products can be classified in the following way:-

Several scientific articles report about the therapeutic role of different compounds of coconut oil and coconut water. But there are insufficient data underlying molecular mechanism of action, pharmacokinetics, bioavailability, efficacy, toxicity and authenticity. So a proper strategy needs to be adapted to address this gap. Quality of a product depends on the reproducibility of the outcome, efficacy and the safety of the product.

Clinical Trial

Current drug development strategy is focused on synthetic molecules which are expensive and extensive. Starting from screening the thousands of synthetics molecules, then filing Investigational New Drug (IND) application with FDA, followed by phase I, Phase II and Phase III of clinical trial as well as reviewing the new drug application and then launching the drug to market takes almost 10 to 15 years, on average and costs over $900 million. This lengthy and expensive drug development process is an obstacle for combating with rapidly emerging and sporadic diseases. Beside this, the concept of single molecule drug treats a single disease based on the concept that "the human diseases have a uniform and underlying genetic basis across patient's population". But the polymorphic nature of several diseases suggests that single molecule based treatment may not work in several diseases. Rather than single target, botanical drugs offer a holistic approach toward diseases. To reduce the cost of drug development and to offer a holistic approach towards the treatment, botanical drugs are ideal. Because of therapeutic efficacy, coconut products may be the promising source of different botanical drugs. For effective integration of botanical drug into modern therapeutics practices three important research needs to be conducted : botanical medicine quality and standardization, preclinical and pharmacological assessment and studying the mechanism of action and clinical efficacy and safety assessment.



Although the volume of research on coconut product has increased over the past few decades, there are still insufficient data on the *in vivo* efficacy and effectiveness of coconut product. Several research articles report the health benefit of coconut oil and coconut water. Based on in vitro and animal model study the following therapeutic role of Virgin coconut oil has been reported by several groups (Table 1).

Table 1. Therapeutic role of virgin coconut oil and its medium-chain fatty acids

Sr. No.	Role of Virgin coconut oil and its medium-chain fatty acids	Therapeutic strategy
1	Antimicrobial activity (Antibacterial, antifungal, antiviral.)	Propionibacterium acnes, Candida albicans, Candida mycelia, Herpes labialis, Candida and Gardnerella vaginalis, Campylobacter jejuni, Salmonella spp., Escherichia coli. Neisseria gonorrhoeae, Staphylococcus aureus. Respiratory syncytial virus Parainfluenza virus type 2
2	Cardiovascular Health	Reduces the risk for CHD, Prevents Blood Pressure Elevation and Improves Endothelial Functions, Hypolipidemic effect, Protection against oxidative stress in heart
4	Diabetes	Insulinotropic effects, Anti-diabetic effects
	Epilepsy and other Neurological Disorders	Drug-resistant epilepsy, Amyotrophic lateral sclerosis
	Intestinal Health	Prevent colitis, Anti-inflammatory, Improve symptoms of primary intestinal lymphangiectasia, Anti-diarrhoea
	Kidney Health	Prevent renal necrosis, nutritional support of acute renal failure
	Skin Health	Anti-bacterial, anti-inflammatory, antinociceptive, Prevent Atopic dermatitis, enhance skin's innate antibacterial defense, wounds healing
	Weight Management	Reduce visceral adiposity

In spite of the fact that so many therapeutic roles of VCO were revealed by *in vitro* study, few health care products came from bench to market. For example, antimicrobial role of VCO and its medium-chain fatty acids have been reported by several research groups. Coconut oil shows significant antifungal activity against Candida albicans and MCT have significant antibacterial activity against Propionibacterium acnes, Staphylococcus aureus, E. vulneris, Enterobacter spp., and Enterococcus spp, Klebsiella and Escherichia coli. Besides this virucidal activity of MCT against Respiratory syncytial virus, Parainfluenza virus type 2 is also reflecting the wide spectrum antimicrobial activity of VCO. But till now, few trials have been conducted to explore the antimicrobial efficacy of VCO and develop the product.

In spite of the possibilities of wide spectrum use of coconut product, the market potential is curtailed by the lack of standardization and scientific validation. Efficacy of the product should be evaluated through well designed multicentric clinical trial. Besides this, systemic review and metanalysis of existing clinical evidence is needed to be carried out in line with the therapeutic efficacy of coconut product.

Based on the available data from clinicaltrial.gov, therapeutic efficacy of coconut oil has been tested to treat following diseases (Table 2).

Table 2. Clinical trial carried out to study the therapeutic role of virgin coconut oil.

Category	Conditions	No of Trial
Antimicrobial	Hansen's Disease,Oral Salivary Streptococcus Mutans Counts, Blood Stream Infection,	3
Cardiovascular Diseases	Chronic Coronary Artery Disease, Peripheral Arterial Disease, Vascular Parameters	3
Alzheimer's Disease	Alzheimer's Disease	2
Skin Disease	Trans Epidermal Water Loss, Trans Epidermal Water Loss, Dermatitis,	3
Digestive System Diseases	Cholestasis,	1
Nutrition	Ketogenic Effect, Glycaemic Response and Energy Balance, Plasma Homocysteine Levels	3
Metabolic Diseases	Diabetes Mellitus Type 1, Obesity	2

According to clinical trials.gov ("a registry and results database of publicly and privately supported clinical studies of human participants"), in India one trial on coconut oil, entitled "Nutritional Assessment Tool and Nutritional Intervention in Childhood Chronic Liver Disease" was conducted by Institute of Liver and Biliary Sciences, India. Another trial on "Effect of Coconut Oil Application in Reducing Water Loss from Skin of Premature Babies in First Week of Life (TEWL)" has been completed by All India Institute of Medical Sciences, New Delhi. Besides this another three trials conducted on cardiovascular disease, skin infection and Oral health were reported by Amrita Institute of Medical Sciences and Research Center (Kerala), The Kelkar Scientific research center (Maharashtra) and Army College of Dental Sciences (Andhra Pradesh) respectively.

Roadmap

Although volumes of well-designed and organized trials on coconut products has increased over the past few years, insufficient data on mechanism of action, pharmacokinetics, toxicity, and bioavailability are major hindrances for the translation.

Based on the chemical composition of coconut water and coconut oil, it is undeniably true that several health care products and value added products can be generated from coconut water.

Development of the product should be market driven i.e., the goal of the research is to address the market demand and launch the product effectively. So to generate product concept, it is important to identify the customer need. First find the market demand based on people's opinion. As culture and tradition contribute to the customer's market choice, it is always better to conduct different region specific market survey for the domestic and the international market. This will be followed by setting the research goal. Research to accumulate the knowledge for future product development is the heart of coconut agribusiness.

Deficiency of information on market opinion or demand based priority area of research, financial support, equired research data, co-operation between different organisations, knowledge about the efficiency and the safety of the product and database for compiling all the relevant information about coconut research are the present limitations of coconut based product development.

Exploring the market opportunity and developing the product to appeal to the identified market is the foundation of sustainable market of coconut products. So, to put forward the final roadmap of strategic research policies it will be ideal to implement policies like setting up the key priorities of product development, shaping the research goal from the collective focus on key priorities, setting up the priority area of future research, reviewing the current research or practice, starting high quality evidence based research and stoping arbitrary claiming, proposing the standard protocol and methodology, develop the online resources to support and enhance the research, organizing meetings for research discussion, increasing collaboration and share resource and maintain interactive network encouraging the research which is the heart of any sustainable agribusiness. etc.

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Coconut for hair care

Deepthi Vijayan, Technical Assistant, Foreign Trade, CDB, Kochi-11

The world today tends to go back to our age old culture and tradition, realizing its true virtue. Thus we are slowly returning to coconut and its value added products for a holistic healthy approach. Coconut in its various forms oil, cream, pulp and tender meat are very old miracle nourishment which are an integral part of our daily life and acts as exquisite beauty care aid.

Coconut is a natural carrier of numerous healthy vitamins and minerals. The application of this wonder nut can never be restricted to a single use. Advanced processing technology makes it possible to reach the goodness of coconut to all through various value added products. Coconut has done wonders in cosmetic sector too.

Coconut and hair care

Coconut in its various forms is a major ingredient in many of the beauty products. It is the most hair friendly product. From time immemorial, Indian culture has always encouraged the role of coconut in hair care. Alongwith women, men are also getting conscious about this crowning beauty. Coconut provides an excellent solution to unruly and unmanageable hair thereby making it lustrous. Coconut oil and coconut cream are the most powerful solutions to all hair types, till date. Coconut hair oil Irrespective of age, gender and all other differences, the vitamin E enriched natural hair nourisher is undoubtedly the most trusted natural beauty secret providing soothing recovery. Hair oiling using coconut oil is an age old Indian tradition. Coconut oil nourishes hair from the roots to ensure natural and healthy growth. It is rich in Vitamins and proteins that can enhance the natural beauty and sheen of hair. Unlike other oils, coconut hair oil can penetrate deep into the hair shaft, rejuvenate it and enhance natural strength and stability. It lubricates hair shaft as it contains minerals like potassium, magnesium, calcium and iron. Studies have shown that coconut hair oil is capable of reducing hair fall, split ends, dry scalp and dandruff. Coconut oil is also augmented with high level of anti bacterial, anti microbial, anti fungal, anti oxidant and moisturizing properties, that keeps the hair smooth, silky, germ free, young, glowing and guarantee longevity and beauty. When used as pre-wash and post-wash grooming product, this natural oil is found to prevent protein loss in dry damaged and brittle hair to a remarkable extend.

Coconut hair cream

Just like coconut oil, coconut hair cream is also beneficial to hair in many ways. Coconut hair cream is nothing but a product which is based on coconut milk and has properties to enhance healthy hair growth. Coconut hair cream is non-sticky cream enriched with coconut milk proteins that nourishes and makes hair healthy & silky. It preserves the capillary fibre from attack by weather and nourishes hair by giving natural moisture from roots to ends. In short, the coconut hair cream is a beauty formula that makes the hair softer, shinier and easier to style in a natural way.

Surging high

Indian products have got a strong hold in international markets owing to its wholesome as well as quality aspects. Though the export of coconut hair care products were minimal during the previous years, India has witnessed a significant jump in shipments of coconut hair oil and hair cream in the recent years, which is comprehensible from the export status of these products.

The yearly export data reveals that coconut hair cream has earned about Rs.11.22 crore during the financial year 2015-16. Hair cream is mainly exported to the Middle East countries. Saudi Arabia, UAE, Oman, Kuwait, Qatar, Singapore, Bahrain, Iraq etc are major destinations for coconut hair cream of Indian

origin. Saudi Arabia is the largest buyer of hair cream accounting for 37 percentage of export of coconut hair cream from India, followed by UAE and Oman.

India has recorded reasonable export of coconut hair oil. In the financial year 2015-16, India has exported coconut hair oil worth Rs.22 crores. The major export destinations are Myanmar, UAE, Saudi Arabia, Singapore, US, Poland, Oman, Qatar, Nepal etc. About 45% of exports of hair oil is to Myanmar, UAE and Saudi Arabia. Gulf countries are major buyers of hair care products from India.

The surge in exports of coconut hair cream and hair oil from India can be attributed to the growing demand for coconut hair care products in the international markets. The major Indian exporter of coconut hair care products is Marico Ltd, which has more than half of the share in total international trade of coconut hair oil and hair cream from India. This itself shows the immense potential of these products in the global market. One important advantage of hair care products is that it enjoys great demand in both domestic as well as international markets.

Apart from Middle East Counties, there are several European markets which still remain untapped, but having great demand for hair care products.Recent studies have shown that more European consumers have started using hair oils out of which Italian women stand out for their attraction to hair oils. Usage of hair oils has increased from 28% in 2013 to 34% in 2014. In UK, usage of hair oil is largely driven by younger women, and hence it rose from 11% in 2013 to 18% among women of all ages, while it rose to 27% among women aged 16-24 as per the recent studies.

India's share in the growing world hair care products trade may be relatively small, but the potential of these products and niche markets portrays the extensive opportunities available for entrepreneurs and exporters in coconut hair care product sector. ■

Healthy Coconut Soap

Akhil M.V, Technical Assistant, Export Promotion, CDB, Kochi-11

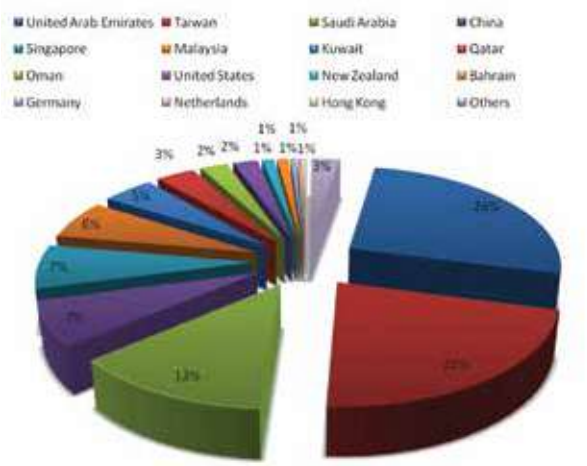
Soaps are made by treating oils and fats with a strong alkaline solution. The fats used in most of the bathing soaps that are cheaply available are animal based fats especially tallow which is a byproduct of beef industry. Animal fats were preferred for soap production over vegetable oil because vegetable oils are costlier than the animal fats which are mere byproducts of meat production industry. Due to the increase in demand for cruelty free and vegetarian products and further increase in the purchasing power of consumers, the niche market of vegetable oil based soaps are growing very fast.

Many vegetable oils like coconut oil, olive oil, canola oil, apricot kernel oil, avocado oil, palm oil etc. rich in fatty acids are used for making soaps.

Health benefits of coconut oil based soap

Coconut oil based soaps are known for its hardness and quick fluffy lather and is one of the best surfactants available because it lather easily in hard water and even in saline water. Coconut oil is light and not greasy and is resistant to spoiling and hence it can be used to make high quality soaps with a long shelf life. Coconut oil based soaps are also known to be good for health of the skin.

Coconut oil based soap nourishes the skin and keeps it soft and smooth, thus prevents premature ageing and wrinkling of the skin. Coconut oil gives nutrition and energy to the skin for healing and maintaining itself thereby making skin more healthy and young. The anti microbial and anti fungal properties of coconut oil based soaps prevent many common skin diseases. Coconut oil soaps are effective in deep cleansing the skin and are a good option for treating acne. The anti microbial properties of coconut oil based soap prevents further occurrence of acne. Use of coconut oil soaps will also help in reducing the chance of sunburn to a certain extent.



Current export scenario

Coconut oil based soaps manufactured in India are having great demand in both domestic and international markets. Coconut oil based soaps worth Rs. 31.77 crore was exported from India during the FY 2015-16 to various countries viz. UAE, Taiwan. Saudi Arabia, China, Singapore, Malaysia etc. The GCC countries are the biggest export destination for coconut oil based soaps of Indian origin. More than 50% of coconut oil based soaps are being exported to the GCC countries. United Arab Emirates which imported coconut oil based soap worth Rs. 8.32 crore in the FY 2015-16 is the largest importer of coconut oil based soap followed by Taiwan and Saudi Arabia which imported Rs. 6.94 crore and Rs. 4.05 crore worth of coconut oil based soap respectively.

Export of coconut oil based soaps from India during FY 2015-16

Sl. No.	Country	Quantity in MT	Value Rs in lakhs	Percentage Share
1	United Arab Emirates	375.06	838.42	25.14
2	Taiwan	310.40	693.87	20.81
3	Saudi Arabia	181.22	405.10	12.15
4	China	100.72	225.14	6.75
5	Singapore	99.49	222.40	6.67
6	Malaysia	89.14	199.27	5.98
7	Kuwait	64.96	145.21	4.35
8	Qatar	49.00	109.53	3.28
9	Oman	35.24	78.78	2.36
10	United States	31.06	69.42	2.08
11	New Zealand	15.24	34.06	1.02
12	Bahrain	14.95	33.42	1.00
13	Germany	6.64	14.83	0.44
14	Netherlands	6.30	14.08	0.42
15	Hong Kong	4.88	10.91	0.33
16	Others	36.96	82.61	7.20
	Total	1421.25	3177.06	100.00

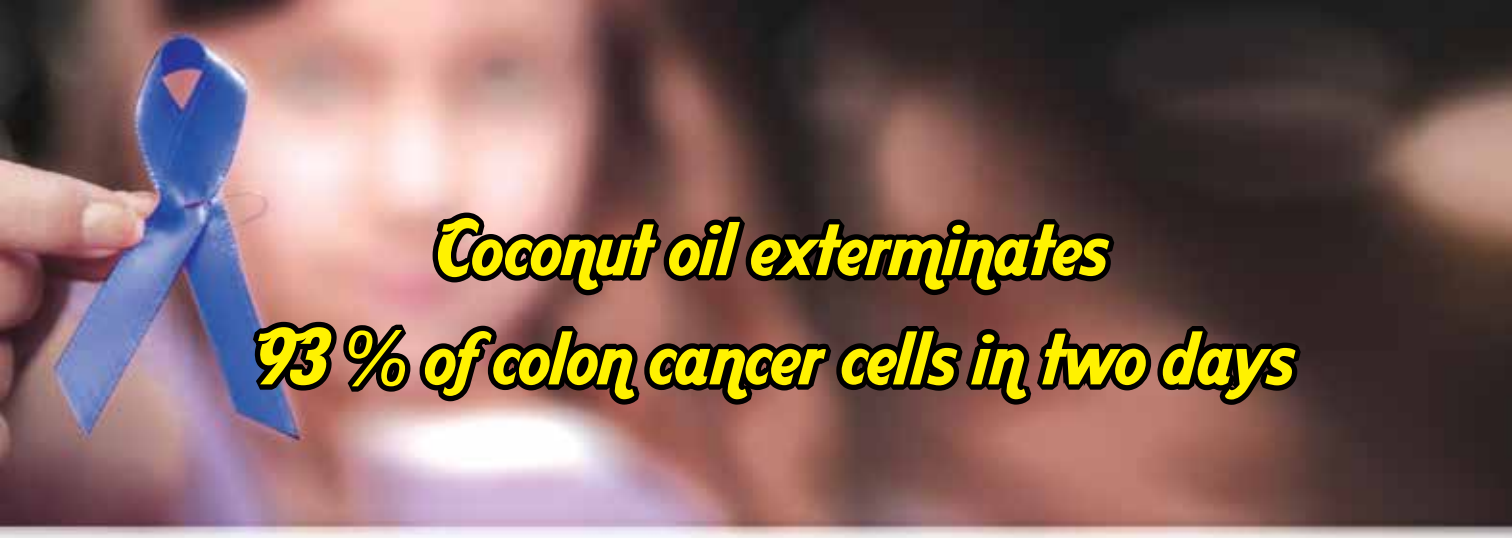
Medimix Ayurvedic soap manufactured by Cholayil Private Limited is the largest brand of coconut oil based soap exported from India. Medimix Ayurvedic soap worth Rs. 31.49 crore was exported from India during the FY 2015-16, which is around 99% of the total export of coconut oil based soaps.

Future Potential

As per the research by 'Markets and Markets' the global surfactants market is estimated to grow at a CAGR of 5.3%, by volume and 5.5%, by value, during the period from 2015 to 2020. The global surfactants market is projected to reach a volume of 24,037.3 kg tonne and a value of USD 42,120.4 Million by 2020. The soap/detergent application segment holds the largest share of the global surfactants market, accounting for over 46% of the global market, in terms of both volume as well as value. The increasing demand for eco-friendly and plant based surfactants (including coconut oil soap), specifically from the European and North American regions, is driving the growth of the global surfactants market. Regulations and non-toxicity are among the main factors favoring the use of plant-based surfactants in these regions.

According to industry analysts, 'Freedonia Group' of Chicago the most important trend in the personal care industry is the rise in demand for botanical extracts in cosmetics and toiletries which is expected to increase to USD 1.0 billion in 2016.

The change in the purchasing pattern of people which is in favor of natural, cruelty free and vegetarian soaps opens up good opportunity for coconut oil based soap industry. Since most soap except coconut oil based soaps does not lather well on hard water it will be highly accepted in places where the water is hard. It is expected that the demand for coconut oil based soap will increase worldwide in the coming years. ■

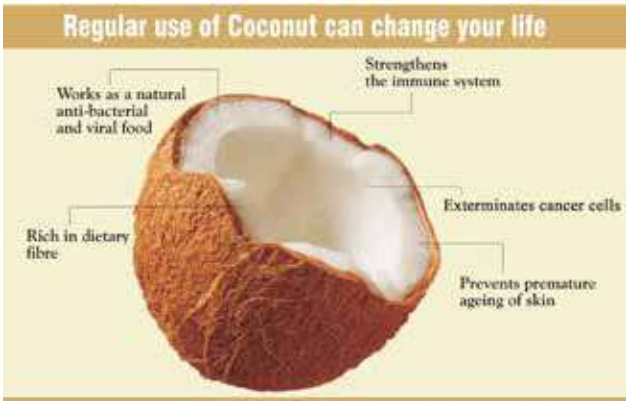


Coconut oil exterminates 93 % of colon cancer cells in two days

Colon cancer is one of the most common cancers among both men and women, and although a number of natural remedies have been linked to the prevention of this disease, government health authorities are quick to mention that not enough research has been done to warrant prescribing them. A recent study conducted by the University of Adelaide, Australia has found out that coconut oil exterminates 93% of colon cancer cells in two days.

There is an active anti-cancer component in coconut oil that constitutes 50 percent of its makeup. It's called lauric acid, and in a study published in the journal Cancer Research, researchers at the University of Adelaide discovered that component completely exterminated more than 90 percent of colon cancer cells after just two days of treatment in a colon cancer cell line (CRC) *in vitro*. The study also reports/cites studies that postulate and indeed support the position that lauric acid can induce cancer cell death both *in vitro* and *in vivo*. For this study, the researchers used the rat small intestinal cell line as a model of normal intestinal epithelial cells, which again, "demonstrated that lauric acid induced considerable cell death."

United Nations University reports that, experiments are being conducted with animals to find out how coconut oil can guard against cancer and have already yielded some interesting results.



More On Coconut Oil

Lauric acid, the colon cancer killing property within coconut oil, is typically found in breast-milk as well. It's a medium-chain fatty acid which supports the immune system and has plenty of antimicrobial properties. Some people consider raw, organic, virgin coconut oil to be a superfood that can help heal cancer and other disease, and studies like the one above support that assertion.

According to the American Society for Nutrition, clinical studies have also shown that the fats found within coconut oil (MCFAs) "may be useful in treating and preventing diseases such as diabetes, osteoporosis, virus-related diseases (mononucleosis, hepatitis C, herpes, etc.), gallbladder disease, Chrohn's disease, and cancer."

Coconut oil has even been shown to decrease the side effects of chemotherapy and improve the quality of life for cancer patients.

source: www.www.collective-evolution.com

Coconut milk, next best thing to mother's milk

Coconut milk, extracted from coconut kernel is proved to be the next best thing to breast milk. Lactose in dairy milk is difficult for many people to digest, while coconut milk does not contain the lactose and it can be used as a substitute for dairy milk to those with lactose intolerance. In situations when a baby is not getting breast milk or needs supplements, coconut milk is widely used in place of cow milk. It is a popular choice of vegans and makes a great base for smoothies, milkshakes and as a dairy alternative in baking.

Nutritional highlights

High amount of fiber – coconut milk is one of the few liquids, which contains high amount of fiber. This is mainly because coconut milk is made from grating the meat of coconut and mixing with water. The grating process leaves fiber behind and it is important for nutrition because it aids in digestion and alleviates constipation. A cup of coconut milk has 5 grams of fiber, which is 18% of the 28 grams required in a 2000-calorie diet.

Assists in Preventing Heart Related Conditions – the medium chain saturated fatty acids in coconut milk are important in improving the health of the arteries. According to research on Filipino women who consume coconut milk frequently, they had healthier lipid profiles when compared to others from different parts of the world. Lipid profile is the major determinant of heart related condition. In addition the medium chain fatty acids in coconut milk help in killing three kinds of bacteria that are responsible for causing plaque formation in arteries which may lead to heart disease.

Healthy Skin and Hair – coconut milk contains a wide range of nutrients; the nutrients are beneficial in the fortifying and conditioning of the hair and skin. Fatty acids in coconut milk are natural antiseptic, which helps in alleviating skin infections, dandruff, itchy skin, and healing wounds. In addition they serve as natural moisturizer and it helps in repairing aging skin, wrinkles, acne and improving the hair sheen.

Oxygen Support – coconut milk nutrition is essential because the iron in the milk helps in transportation of electrons to mitochondrial cells, DNA synthesis, and transport of oxygen to different parts of the body through hemoglobin. Hemoglobin is key in the transport of oxygen from the lungs to other parts of the body and removing carbon dioxide from the cells for excretion. Moreover, coconut milk helps in preventing muscle fatigue, anemia, and heart irregularities.

Calm Nerve Cells – Coconut milk is high in magnesium that helps to keep blood pressure at a normal level. The combination of calcium and magnesium in coconut milk also keeps muscle and nerves from becoming over stimulated.

Coconut milk, curbs the growth of breast cancer cells.

Coconut milk contains kinetin riboside, a substance that has been shown to curb the growth of multiple myelomas and is thought to have the potential to inhibit the progression of many other cancers, including prostate, colon, parathyroid adenoma, certain lymphomas and breast cancer. A study has found out that carcinogen-induced mammary tumors in mice were reduced as much by coconut oil as by menhaden oil compared to a corn oil diet.

Strengthen Bones – Coconut milk does not contain as much calcium as dairy milk but it does contain high amounts of phosphorus that can help to strengthen bones.

Fight Virus and Infection – The lauric acid in coconut milk will be converted to monolaurin in the body. This compound contains antiviral and antibacterial properties.

Regulate Blood Sugar – The manganese in coconut milk helps metabolize glucose in the body to help the metabolism working at the optimum level. Manganese can also help to prevent osteoporosis, PMS, inflammation and vitamin absorption.

Lowers Cholesterol – Coconut milk with its medium chain saturated fat, raises the HDL or good cholesterol while dairy based products raise the LDL or bad cholesterol. The fat in coconut milk is easy for the body to metabolize which will lowers the overall cholesterol levels. ■

Health benefits of Virgin Coconut Oil on neural-immune network

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The recent Global Burden of Disease Study 2010 has reported that the life expectancy in India has increased, but the number of years during which the elderly stay healthy is lesser. Although, the aging population of India is not that high compared to the Western countries, it is predicted to rise in the future. Already, there are reports indicating an increase in the incidence of age-associated diseases such as neurodegenerative diseases (Alzheimer's disease and Parkinson's disease), autoimmune and infectious diseases and cancer. This statistical information add urgency to understand the physiological processes and the molecular mechanisms involved in aging process in humans and develop strategies to effectively deal with age-associated increase in the incidence of pathological diseases.

The "mind-body" interactions in maintaining the physiological and psychological well being of an individual is achieved through coordination of neuroendocrine and immune systems in the body. When the equilibrium in their functioning is disturbed by external or internal threats, these systems are activated to restore the internal environment to normalcy. An imbalance in the crosstalk between these systems leads to failure in mounting an appropriate immune barrier, predisposing the individual to various disorders. This is true with respect to aging and incidence of diseases such as neurodegenerative diseases and cancers [1]. Contextually, the natural and synthetic therapeutic interventions which can reverse the age- and disease-related alterations in body, by enhancing immunity, can be beneficial. We have found that natural remedies like Brahmi (Bacopa monnieri) [2,3] and Noni (Morinda citrifolia) fruit juice [3] can enhance immune reactivity by influencing the antioxidant status in immune organs and through intracellular molecular pathways. The antioxidant enzymes are critical in removal of free radicals that impair the functions of neuroendocrine and immune systems in aging and diseases

Cocus nucifera Linn oil has been used for several centuries in India and South-East Asia, both as part of diet and for medicinal value. Therapeutically, coconut oil has been used as such or as a part of Ayurvedic preparations. The unique properties of coconut oil underwent a lot of criticism in the past because of the belief that the presence of high saturated fat content might be detrimental to health, which later on was found to be not true [4]. Virgin Coconut Oil (VCO) metabolizes rapidly, which renders it to be the ideal dietary fat. Dietary intake of VCO is beneficial as it increases energy expenditure and reduces fat deposition. In addition, it provides with a pool of essential constituents of body fats which are not preserved in the adipose tissue. Although it has gained attention as a 'functional food' because it provides benefits further than a nutritional source, its health benefits have been only partially exploited. Recently, scientific evidence for its antimicrobial, anti-thrombotic and antioxidant, anti-inflammatory, antitoxic, anti-mutacarcinogenic actions anti-nociceptive and anti-inflammatory actions was provided. [5, 6] Since studies have established multiple physiologically relevant role of VCO, it is essential to investigate whether its beneficial

effects are mediated through enhancing immune system and regulating neural network. This will enable the use of VCO as a valuable functional food for humans and also, may be useful in devising potential treatment strategies for age-related neurodegenerative diseases, autoimmune diseases, etc.

In order to explore its usefulness as a functional food, we conducted a study was conduct in which VCO was fed to young rats orally for a month and its effects on immunity were examined at the end of the study period. From this phase of study, it was we concluded that VCO possesses immune-enhancing properties in response to external stimuli (antigens) that was demonstrated by an increase in lymphocyte number and immune molecules that are crucial to immunity. This specific role of VCO may be selectively implemented in numerous treatment strategies for inflammatory diseases, such as Alzheimer's disease.

Several clinical and epidemiological studies have delineated direct correlation of dietary fats with cardiovascular illnesses [7, 8], and thus, functional foods that are hypolipidemic in nature are promoted worldwide. In our study, concurrent to the previous findings, VCO is found to be cardio-protective as it increases good cholesterol levels while decreases bad cholesterol in the serum. Furthermore, human trial has proved the efficacy of VCO intake and has established that it is beneficial to reduce waist circumference in men, owing to the presence of medium chain fatty acids, which are rapidly utilized by the body in energy homeostasis without contributing to body fat reserves [9]. In addition, considering the increasing prevalence of life style-related disorders, the search for a functional food that has potential positive effects on health beyond providing basic nutrition, urge more attention. As a dietary supplement with established hypolipidemic and antioxidant properties may also have anti-ageing properties by regulating the basal metabolic rate and quenching the free radicals that in turn would prevent cell death and subsequent organ damage.

In future, it is critical that we further explore the beneficial effects of dietary intake of VCO in different age groups of animals and healthy men and women. This will enable us to understand the mechanisms of alterations in aging and potential use of VCO as an intervention strategy to promote healthy aging. With India being one of the largest producer of coconuts in the world, the need of the hour is to exploit its beneficial health effects and promote the Indian economy. ■

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Best management practices yield record results

● **Sasikumar C**, Technical Officer, CDB, Kochi-11

Coconut farmer from Tamilnadu records a production of 370 nuts from DxT palms through best management practices

P. Dharmaraj, a farmer from Kottur Malayandi pattinam, Pollachi, Tamil Nadu has harvested around 350 to 370 nuts per palms from his coconut garden. Dharmaraj a B.Sc. (Ag.) graduate from TNAU, Coimbatore has served for 27 years as Agricultural Officer in the Department of Agriculture, Government of Tamil Nadu. He possesses 11 acres of coconut land having 740 yielding trees and he has planted DXT and few Chowghat Orange Dwarf palms in his garden. The DXT seedlings were procured from Navlock Farm, Vellore and Deejay Farms, Madurai.

Seedling Selection

He advises that selecting a seedling from a good quality nursery is crucial for the growth and regular bearing of the palm. Dharmaraj is very selective in choosing his planting material. Since coconut is a perennial crop, one should be careful about its mother palm characteristics and nature of bearing.

Land and soil

The soil type of his garden is red loamy and sandy, the land should not be water stagnated and should have proper drainage facility. If the soil in the land is acidic or alkaline in nature, it should be properly reclamated and then only one should go for planting. It is better to have levelled land and should have water table. Generally red, loamy and sandy soils are best for undertaking coconut cultivation. Spacing should be maintained properly. He has planted the DXT varieties by 25X25ft and Dwarf varieties are planted at a spacing of 20X20ft.

Irrigation

Coconut palm is usually grown well in coastal sandy areas and is a water loving plant by gene. Hence proper irrigation is a must for the better growth and yield of coconut palms. In Tamil Nadu, the main coconut belts are not situated in the coastal areas. However the farmers have established proper irrigation facilities to coconut, and is reaping the full potential yield. They have even made a coconut revolution in the sector in the country by making the record coconut production. Drip irrigation (dripper) is undertaken in the farm for watering the palms. He is providing irrigation @ 350 liters per day per palm and for those palms in the sandy soil @ 400

liters per day. For manuring, the farmer has adopted best management practices. i.e. urea 2 Kg, DAP 3 Kg, MOP 4 Kg, Micronutrients 1 Kg, Gypsum 4 Kg, common salt 1 Kg and farm yard manure 100 Kg per year.

The manure is applied through fertigation except gypsum and farmyard manure. Application of manure is divided into twelve splits and is fertigated. However before fertigation, the soil should be made wet or moistured through drip by 20 minutes followed by fertigation with manure for 30 minutes and finally again the land should be watered for another 20 minutes. He is doing this practice to 40 trees per shift. Dharmaraj is tapping to the fullest the potential of DXT palms, which yields better through better management practices which is not possible in tall and dwarf coconut varieties. This enables him to reap a yield of minimum of 320 nuts and a maximum of 370 nuts per tree. Since his farm is located near a hilly area, natural pollination is very much possible in his farm which adds on to the rich nut setting of his palms.

Organic farm

During the last five years, he has been maintaining his garden as organic garden by using only farm yard manure. He opines that the productivity of a palm can be decided by the farmer himself. He is applying one kg farmyard manure for one nut per year. If a farmer likes to harvest 350 nuts he should provide 350 kg of decomposed FYM per tree in two or three splits so that he can reap the harvest as desired. Presently he is spending Rs.300 per tree and is harvesting 250 nuts per tree per year. The decomposed FYM is dumped in the basin of the tree and ploughed by using power tiller for mixing thoroughly with the soil and then the basin is mulched with coconut fronds. He is maintaining a spacing of 25X25ft, wherein six feet is covered with mulch and the balance 19 fts is open for the cattle to graze.

Dharmaraj is using his coconut palms exclusively for tender nut harvesting and is making good profit through the sale of tender nuts. On an average he is getting Rs. 15 per nuts per year and during the peak summer season he is getting Rs.20 per nut.

Dharmaraj, a member of the Pollachi Tender Coconut Growers Association is serving as a technical advisor to farmers. He is free to offer his advice to all those who are interested in coconut farming. Dharmaraj has also authored a book named 'Thennai endre devamrutham' in Tamil which covers the basic details of establishing a good coconut garden. He can be contacted on: 09788499404

Another women farmer Dr. A. Shanmuga Priya from Amme Goundanoor, Pollachi, a Ph. D holder in Biotechnology harvesting a maximum of 170 nuts from her West Coast Tall palms, since 1998. She is the wife of Mr. T. Rathinasabapathi, Director, Pollachi Coconut Producers Company ltd, Pollachi. The garden is maintained with various intercrops such as nutmeg, banana and fodder grass. She is also into organic farming and is undertaking drip irrigation.

In her seven acre garden she is rearing around 500 trees which are mainly WCT, COD and MYD varieties. She is following best management practices in her garden and is spending around Rs. 200 per tree per year and is harvesting 170 nuts.

Dr. A. Shanmuga Priya is also having nurseries of coconut, nutmeg (budded) and arecanut. Coconut seedlings of Chowghat Orange Dwarf, West Coast Tall, Malayan Yellow Dwarf and Chowghat Green Dwarf varieties are available in her nursery. Dr. A. Shanmuga Priya can be contacted on 09443029259. ■

'Jus- Coco' coconut milkshake launched

For the first time in India, coconut milk has been launched commercially in a ready to drink form. Pure Tropic, a Tiruppur based company has launched the product under the brand name 'Jus Coco'. The product is introduced in the market as Coconut Milk Shake in four different flavors - vanilla, chocolate, pineapple and cardamom. Pasteurized at ultra high temperature and packed in tetra packs under aseptic conditions, the product has a shelf life of six months. 'Jus Coco' is available in market at Rs. 30 for 200 ml. The new dairy free vegan product marks the beginning of a new revolution in coconut sector.

Export of Indian Coconut products increased by 10.50 percent

K.S. Sebastian, Assistant Director, Export Promotion, CDB.

Export of coconut products during the financial year 2015-16 touched Rs. 1450.24 crores. Compared to the export during the previous year an increase of 10.50% was recorded in coconut product exports. Significant increase was recorded in the export of desiccated coconut, activated carbon and coconut oil. Export of coconut products from India during 2015-2016 is given in table 1.

Table1

Export of coconut products (2015-16)				
Items	March 2016		April 2015 to March 2016	
	Cum. Qty (in MT)	Cum. Value (Rs. In lakhs)	Cum. Qty (in MT)	Cum. Value (Rs. In lakhs)
Activated Carbon	5798.81	6027.95	61212.58	63208.13
Coconut Fatty Soap		202.89		3177.06
Hair Cream		140.30		1121.33
Coconut Oil	1020.66	1636.03	8549.97	17540.30
Coconut Water		35.79		728.53
Copra	2675.26	1883.70	6749.21	5292.61
Desiccated Coconut	1105.63	1142.99	4260.97	5260.61
Dry coconut	1671.85	1326.84	18303.04	17846.79
Fresh coconut	4029.05	1208.72	39800.46	14960.52
Grated/sliced coconut	239.34	394.46	2163.52	3916.26
Oval coconut shell	149.43	97.13	1630.26	913.64
Shell charcoal	159.55	62.20	7565.85	2511.52
VCO	47.21	139.10	818.33	2622.50
Misc coconut products		871.78		5924.59
Total		15169.86		145024.38

Activated Carbon

The export of activated carbon from India during the financial year 2015-16 was 61,212.58 metric tonnes. United States was the major importer of Indian activated carbon, followed by United Kingdom. Details of export of Activated Carbon from India is given in table 2

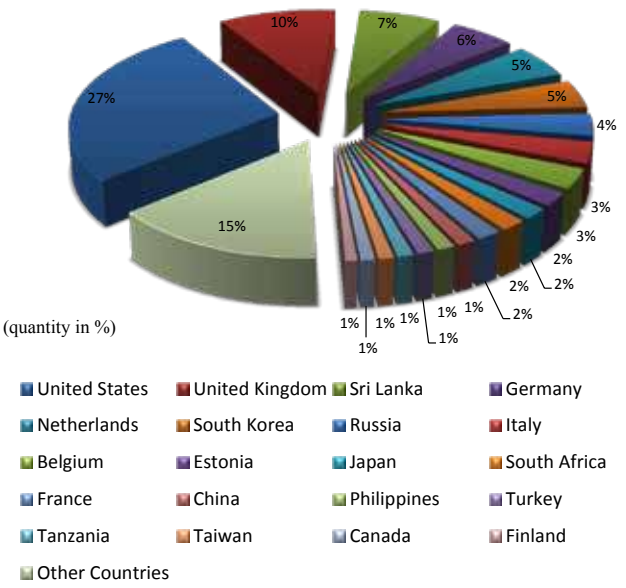


Table 2

Country wise export of Activated Carbon (2015-16)

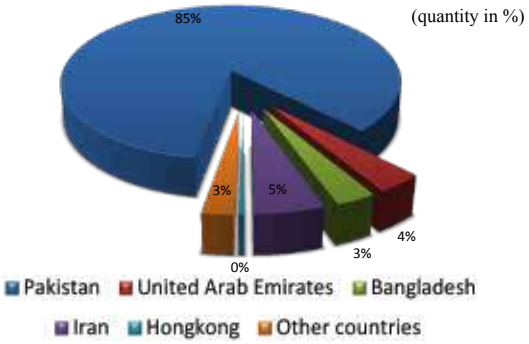
Country	Qty(in MT)	Value(Rs in lakhs)
United States	16656.71	17365.77
United Kingdom	6282.79	6764.11
Sri Lanka	4356.62	3365.07
Germany	3467.70	3785.34
Netherlands	3342.40	3412.69
South Korea	2794.85	3365.92
Russia	2232.30	2392.97
Italy	2067.30	1758.80
Belgium	1968.00	1961.82
Estonia	1318.00	1341.34
Japan	1109.51	1144.54
South Africa	1085.30	1231.49
France	1027.20	1346.06
China	773.20	1036.27
Philippines	738.36	844.57
Turkey	694.30	602.34
Tanzania	670.12	759.75
Taiwan	617.18	704.28
Canada	591.05	624.65
Finland	482.35	432.25
Other Countries	8937.34	8968.11
Total	61212.58	63208.13

Dry Coconut

During the finanical year 2015-16, 18,303.04 metric tonnes of dry coconuts were exported from India. Out of this 15,539.90 MT was to Pakistan. Countrywise export of dry coconut from India is given in table 3.

Export of dry coconut (2015-16)		
Country	Qty (in MT)	Value (Rs in lakhs)
Pakistan	15539.90	15222.88
United Arab Emirates	680.29	688.81
Bangladesh	575.00	392.98
Iran	984.20	885.88
Hongkong	77.59	160.54
Other countries	446.06	495.71
Total	18303.04	17846.79

Table 3

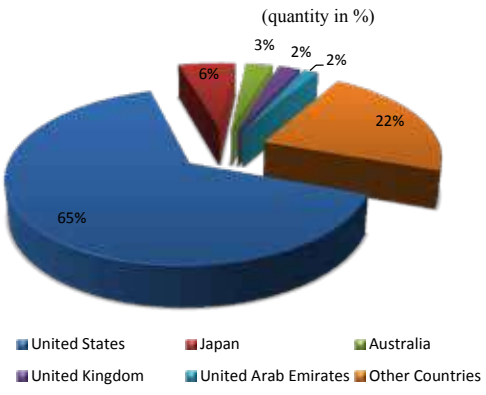


Virgin Coconut Oil

Export of virgin coconut oil from India during the financial year 2015-16 was to the tune of 818.33 metric tonnes. United States alone imported 532.11 metric tonnes of VCO from India. During year 2014-15, the export was only 789.38 metric tonnes. Countrywise export of virgin coconut oil from India in 2015-16 is given in table 4.

Export of VCO (2015-16)		
Country	Qty (in MT)	Value (Rs. In lakhs)
United States	532.11	1612.11
Japan	49.87	117.73
Australia	23.84	68.01
United Kingdom	19.11	59.32
United Arab Emirates	12.71	69.45
Other Countries	180.68	695.88
Total	818.33	2622.50

Table 4

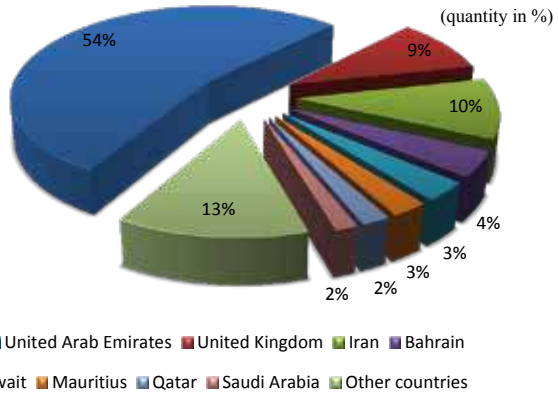


Fresh Coconut

Export of husked coconut from India during the financial year 2015-16 was 39,800.46 metric tonnes. Major portion of export was to UAE. Countrywise export of fresh coconut from India is given in table 5.

Export of fresh coconut (2015-16)		
Country	Qty(in MT)	Value (Rs in lakhs)
United Arab Emirates	21425.40	8835.72
United Kingdom	3745.20	1641.56
Iran	4090.93	1431.15
Bahrain	1727.43	566.99
Kuwait	1280.02	552.16
Mauritius	999.82	339.95
Qatar	775.57	376.44
Saudi Arabia	615.00	236.86
Other countries	5141.09	979.69
Total	39800.46	14960.52

Table 5



Desiccated Coconut

Export of desiccated coconut powder in 2015-16 was 4260.97 MT which was 63.48% more than the desiccated coconut export in 2014-15. In the year 2014-15 the export was only 2606.34 MT. Country wise export of desiccated coconut powder during the year 2015-16 is given in table 6

(quantity in %)

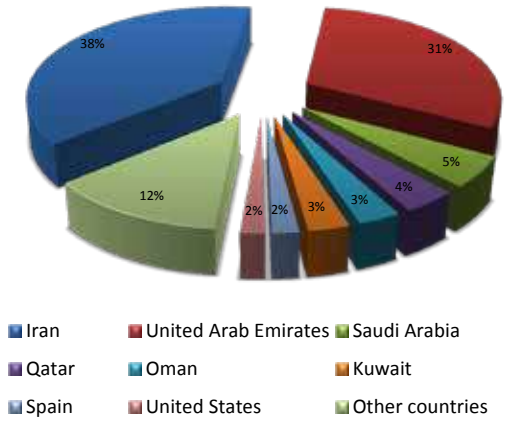


Table 6

Export of desiccated coconut (2015-16)			
Sl.No.	Country	Qty(in MT)	Value(Rs in lakhs)
1	Iran	1638.70	2305.39
2	United Arab Emirates	1302.88	1399.25
3	Saudi Arabia	226.30	331.02
4	Qatar	162.41	183.17
5	Oman	126.55	127.41
6	Kuwait	121.64	180.40
7	Spain	78.00	79.94
8	United States	72.19	93.93
9	Other countries	532.32	560.10
	Total	4260.97	5260.61

Coconut Oil

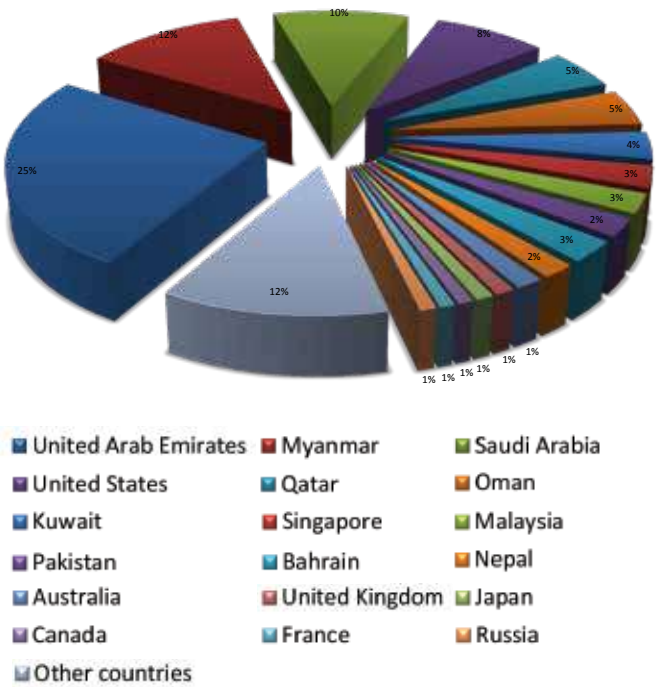
Export of coconut oil from India during the year 2015-16 was 8549.97 metric tonnes, which is 23.28% higher compared to 6935.54 metric tonnes recorded during the year 2014-15. UAE alone imported 2170.93 metric tonnes of coconut oil.

Coconut oil was also exported to Myanmar, Saudi Arabia, United States, Qatar, Oman, Kuwait, Singapore, Bahrain, Malasia, Pakistan, Nepal etc. Export of coconut oil from India is given in table 7.

Table 7

Export of coconut oil (2015-16)		
Country	Qty (in MT)	Value (Rs in lakhs)
United Arab Emirates	2170.93	4064.03
Myanmar	1021.48	2236.63
Saudi Arabia	861.74	1686.16
United States	721.79	1761.14
Qatar	450.36	928.95
Oman	409.02	861.94
Kuwait	312.53	609.05
Singapore	243.62	591.94
Bahrain	241.01	461.34
Malaysia	220.21	515.18
Pakistan	201.98	372.07
Nepal	156.36	277.13
Australia	128.01	318.67
United Kingdom	87.72	212.71
Japan	81.23	169.85
Canada	71.20	128.79
France	68.63	153.73
Russia	75.80	138.27
Other countries	1026.35	2052.72
Total	8549.97	17540.30

(quantity in %)



Import

During the financial year 2015-16, India imported Rs 383.27 crores worth coconut products. Copra expeller cake, coconut fatty acid, coconut oil and coconut shell charcoal were the major items to be imported. Details of import of coconut products into India during 2015-16 is given in table 8.

Import of coconut products (2015-16)				
Item	March 2016		(2015-16)	
	Qty (in MT)	Value (Rs. in lakh)	Cumulative Qty (in MT)	Cumulative Value (Rs. In lakhs))
Coconut fatty acid	524.66	403.23	7987.67	6161.89
Coconut oil	357.00	286.09	5416.30	4460.39
Copra oil cake	21160.91	3121.79	133546.99	20411.02
Coconut shell charcoal	172.30	51.29	11777.89	3730.81
Cream-milk-powder		111.25		1742.06
Copra	0	0.00	291.25	208.45
Misc coconut products		152.62		1612.34
Total		4126.27		38326.96

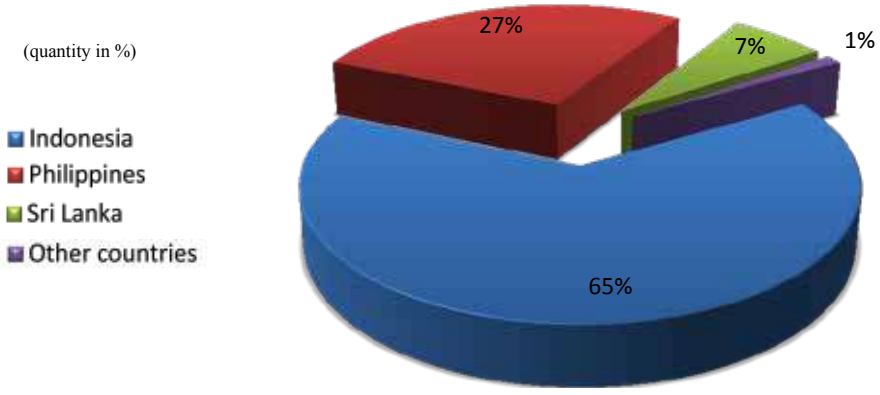
Table 8

Copra expeller cake

One major item of import among coconut products is copra expeller cake. During the year 2015-16, the quantity of import of this product was 1,33,546.99 metric tonnes. During the year 2014-15, the import was 1,13,939.57 metric tonnes. Details of import of this product is given in table 9.

Import of coconutoil cake (2015-16)		
Country	Qty (in MT)	Value (Rs. In lakhs)
Indonesia	86565.89	13379.80
Philippines	36372.81	5364.66
Sri Lanka	9146.38	1453.13
Other countries	1461.92	213.43
Total	133546.99	20411.01

Table 9



Coconut Fatty Acid

Import of coconut fatty acid into India during the financial year 2015-16 was 7987.67 metric tonnes, out of which 7249.39 metric tonnes was from Malaysia. Details of import of coconut fatty acid to india is given in table 9. Import of coconut fatty acid during the year 2014-15 was 8,318.55 metric tonnes.

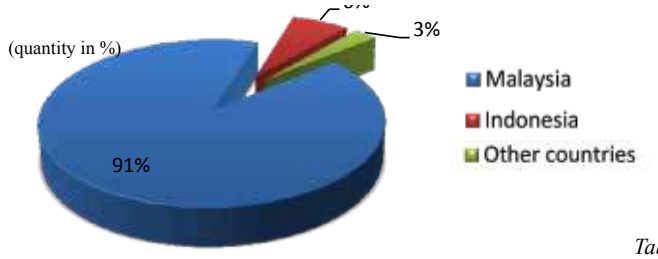


Table 9

Import of coconut fatty acid (2015-16)		
Country	Qty (in MT)	Value (Rs.in lakhs)
Malaysia	7249.39	5578.10
Indonesia	523.00	421.17
Other countries	215.28	162.62
Total	7987.67	6161.89

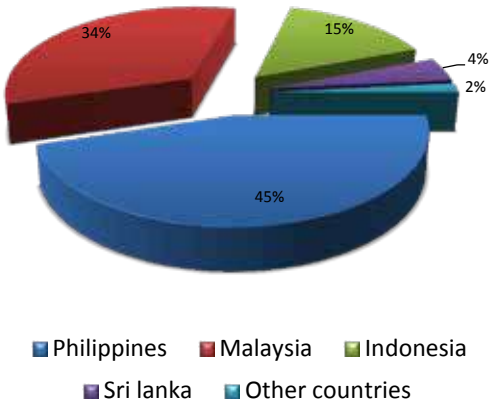
Coconut Shell Charcoal

Import of coconut shell charcoal into India during the financial year 2015-16 stood at 11,777.89 metric tonnes. The highest import was recorded from Philippines. Details of import of coconut shell charcoal to India is given in Table 10. Import of coconut shell charcoal during the year 2014-15 was 14,226.56 metric tonnes.

Import of coconut shell charcoal (2015-16)		
Country	Qty (in MT)	Value (Rs. In lakhs)
Philippines	5324.82	1658.11
Malaysia	3978.79	1250.70
Indonesia	1785.21	612.95
Sri lanka	503.36	157.27
Other countries	185.70	51.76
Total	11777.89	3730.81

Table 10

Table 10

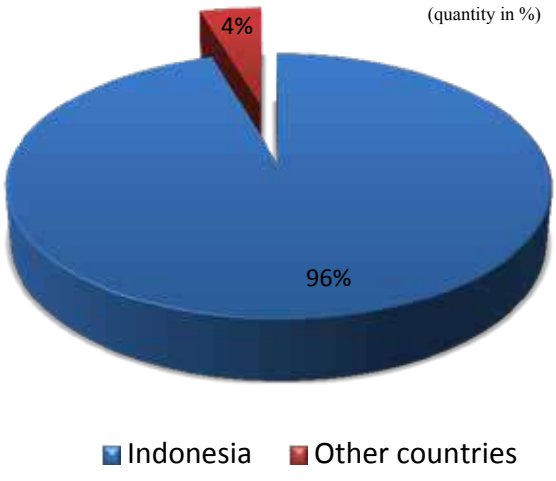


Coconut Oil

Import of coconut oil into India during the financial year was 5416.30 metric tonnes. Highest import was recorded from Indonesia, which was 5172.85 metric tonnes. Countrywise import of coconut oil to India is given in Table 11. Import of coconut oil the year 2014-15 was 12,811.91 metric tonnes.

Import of coconut oil (2015-16)		
Country	Qty (in MT)	Value (Rs. In lakhs)
Indonesia	5172.85	4180.38
Other countries	243.45	280.02
Total	5416.30	4460.39

Table 11



Monthly operations in coconut gardens - May

Andaman & Nicobar Islands:

Plant the seedlings in the previously prepared pit after half filling the pit with a mixture of wood ash, sand and surface soil in a small hole dug in the centre of the pit. Provide bunds along the edge of the pit to prevent water stagnation in the pit. Clean the crown of all the bearing palms and fill the leaf axil with sand and napthalene ball mixture to prevent the attack of rhinoceros beetles

Andhra Pradesh: Prepare nursery beds. Sow seed nuts in the beds. If coconut husk is available bury it in trenches taken 3m away from the trunk between rows of palms or in circular trenches taken around the palm at a distance of 2m from the trunk. The husk is to be placed in layers with concave surface facing upwards and buried. The husk helps in the retention of moisture and supplies nutrients especially potash. The beneficial effect of husk burial will last for 5 to 7 years. Apply the first dose of fertilizers i.e. 400 g urea, 700 g single superphosphate and 750g muriate of potash to adult palms in the basin. Apply green leaf manure@ two headloads per tree and then finally cover with soil and irrigate the basins. If cattle manure is available, apply 25 kg along with the above manures. Apply ¼ cartload of tank silt depending on its availability. Plant one year old seedlings in the main field. If the attack of blackheaded caterpillar is noticed, cut down and burn the affected leaves to arrest the spread of the pest. Spray the affected palms with 0.02 per cent dichlorvos or 0.05 per cent Malathion.

Liberate specific parasites on older palms according to the stage of the pest. In a multi-stage condition of the pest, combined release of all the parasitoids is required. When an initial insecticide treatment is given the parasitoids may be released after three weeks of spraying.

If there is termite problem in the area, raise the nursery in sandy soil or apply thick layers of river sand on the bed or drench the nursery with 0.05 per cent chlorpyriphos twice at 20 to 25 days interval. If the attack of mite is noticed, spray neem oil formulation containing 0.004 per cent Azadirachtin/ Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth year old bunches.

Assam: Continue transplanting of seedlings in the mainfield. Drain out regularly accumulated rain water from the pits of newly transplanted seedlings. Clean the crowns of the palms and tie or prop up bunches to prevent buckling. Take preventive measures against diseases. If termite attack is noticed, adopt soil drenching of the nursery beds and basins of newly transplanted seedlings with 0.05 per cent chlorpyriphos twice at 20 to 25 days interval. Against leaf rot disease, pour contaf 5EC @ 2ml/300 ml of water per palm around the base of the spindle leaf after cutting and removing the rotten portion.

Bihar / Madhya Pradesh/ Chhattisgarh: Increase the frequency of irrigation. Search for the incidence of termite attack/fungal disease and adopt recommended control measures. Start planting seedlings in the field by taking pit size of 1.2m x 1.2m x 1.2m in laterite soil and 1m x 1m x 1m in sandy loam soil.

Karnataka: Clean the water channels and repair the bunds. Continue irrigation, if the monsoon has not set in. Sow the seednuts before the onset of monsoon rains

and irrigate them if necessary. Give a prophylactic spray with, 1 per cent bordeaux mixture or any other copper fungicide against fungal diseases. Fresh planting may be done in previously prepared pits half filled with wood ash, cattle manure and surface soil. Irrigate the seedlings if dry spell prevails. Apply the first dose of fertilizers, organic manure (FYM) @ 50 kg and neem cake @ 5 kg per palm per year. If the attack of mite is noticed, spray neem oil formulation containing 0.004 per cent Azadirachtin/ Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to year old bunches.

Kerala/Lakshadweep: Search for leaf eating caterpillars and destroy them by cutting and burning the leaves infested by them. When an initial insecticide treatment is given, the parasitoids may be released after three weeks of spraying. Search for rhinoceros beetle and red palm weevil in the affected trees. The black beetle should be hooked out and destroyed. Inject the red palm weevil attacked palms with carbaryl 1 per cent using a funnel. Search for bud rot infection. If infection is found, treat with bordeaux paste and spray the neighbouring palms with one per cent bordeaux mixture as a prophylactic measure. Take basins around the palm at 2m radius and sow green manure crop in it if it has not been sown in the main field. Husk burial can be done to conserve soil moisture. Application of sufficient quantities of organic manures and balanced doses of inorganic fertilizers is recommended to improve the nutrient status of palms. Apply organic manure (FYM) @ 50 kg and neem cake @ 5 kg per palm per year. If the attack of mite is noticed, spray neem oil formulation containing 0.004 per cent Azadirachtin/Neemazal@ 4 ml/ litre of water. The spray droplets are to be directed towards the second to fifth year old bunches.

Maharashtra/Goa/Gujarat:

Plough the land once or twice and remove the grasses. Sow green manure crop such as wild sunnhemp, dhaincha, sesbania or kolinji @ 28 to 34 kg per hectare. Apply fertilizers if not given earlier.

Orissa: Dig basins around the palms. Apply green leaf and cattle manure at the beginning of the southwest monsoon. First apply the green leaf and then cattle manure and cover with soil. Apply the first dose of fertilizers @ 250g urea, 300 g single super phosphate and 400 g muriate of potash per palm. ¼, ½ and ¾ of the above doses of fertilizers may be given to 1st year, 2nd year and 3rd year old palms respectively. Start planting seedlings in the main field by taking pit size of 1.2m x 1.2m x 1.2m in laterite soil and 1m x 1m x 1m in sandy loam soil.

Tamil Nadu/Puducherry:

Continue irrigation in the garden. Apply 80 litres of water / day / palm in drip irrigated gardens or apply 500

litres of water / palm through basin irrigation once in 6 days in the western region and once in 5 days in eastern region. Search for black headed caterpillar. If infestation is observed, cut and burn the infested leaves or portion of leaves. If the attack of black headed caterpillar is noticed spray the affected palms with 0.02 percent dichlorvos or malathion and release larval or pupal parasites 3 weeks after spraying. Repeat the spraying with copper oxychloride @ 0.25 per cent / carbendazim 0.1 per cent or root feed with 2 g carbendazim in 100 ml water if grey/lethal leaf blight is observed. Forty-five days interval should be maintained between root feeding and next harvest of nuts. Start sowing of seed nuts in the nursery and sowing of green manure crops like sunnhemp and daincha in the palm basins.

Tripura: Weed the garden and improve the drainage facilities. Transplanting should be taken up during this month. Spray one per cent bordeaux mixture if bud rot is prevalent in the garden. To protect the palms from rhinoceros beetle and red palm weevil fill the top 3-4 leaf axils of the palm with a mixture of 25g sevidol 8G with 250g fine sand. Prepare nursery beds for sowing seednuts. In areas of poor drainage make raised beds. The seed beds are to be treated with 0.05per cent chlorpyriphos twice at 20 to 25 days interval to protect the nuts from the attack of termite.

West Bengal: Prepare bunds and clean the water channels. Continue irrigation if the monsoon has not set in. Sow seednuts before the onset of monsoon and irrigate them if necessary. Dig out pits for new planting if it is not yet done. Give palms a prophylactic spray with 1per cent bordeaux mixture (Dissolve 10 g of copper sulphate and 10 g quick lime separately in 500 ml water. Pour the copper sulphate solution into the lime solution to get one litre bordeaux mixture. Check the acidity by dipping a knife or blade in the solution. If rusting is seen add more lime solution) to prevent bud rot and other fungal diseases. Apply the first dose of fertilizer if not done.

MARKET REVIEW – MARCH 2016

Highlights

- The prices of milling copra and coconut oil expressed a declining trend in major markets in the country during March, 2016.
- The international price of coconut oil and copra expressed an upward trend during March 2016 compared to the previous month.

The month of March 2016 witnessed a declining trend in the prices of coconut, copra and coconut oil at all important markets in the country.

Coconut Oil

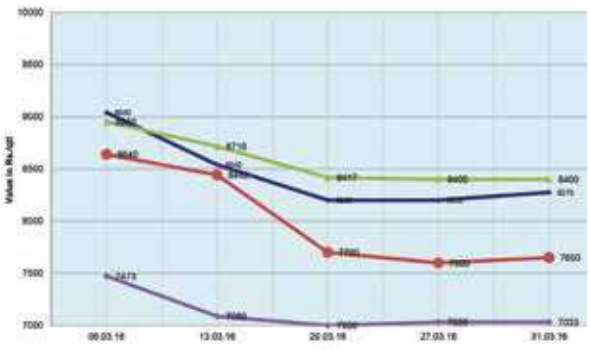
The price of coconut oil which opened at Rs.9,100/- per quintal at Kochi market declined to Rs. 9,000/- on 4th, expressed steady declining trend and reached Rs.8,200/- on 14th . The price which improved to Rs.8,300/- on 29th, ruled steady at the same price and closed at Rs.8,300/- per quintal with a net loss of Rs.800 per quintal. The price of coconut oil at Alappuzha market which opened at Rs.8,700 per quintal declined to Rs.8,400/- on 5th, thereafter expressed a mixed trend and closed at Rs.7,800/- per quintal with a net loss of Rs.900/- per quintal. The price of coconut oil at Kozhikode market which opened at Rs.9,000/- per quintal, declined to Rs. 8,800/- on 5th, thereafter expressed a declining trend and reached Rs.8,400/- on 15th. The price which was Rs. 8,400/- on 15th, ruled steady and closed at the same price with a net loss of Rs.600/- per quintal. The monthly average price of Rs.8,448/-per quintal at Kochi market and Rs.8,025/-per quintal at Alappuzha market were 6 to 7 percent lower than that of previous month and about 39 to 40 percent less than that of the corresponding month last year. The monthly average price of Rs.8,568/- per quintal at Kozhikode market was marginally lower than that of the previous month and about 42 percent less than that of the corresponding month last year. The monthly average price of Rs.7,123/- per quintal at Kangayam market in Tamil Nadu was six percent less than that of the previous month and about 46 percent lower than that of the corresponding month last year.

Milling Copra

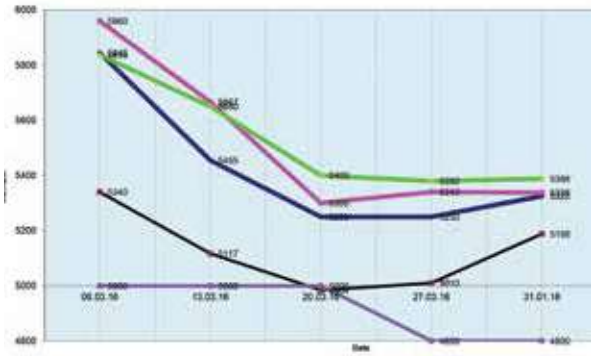
The price of FAQ copra which opened at Rs.5,900/- per quintal at Kochi Market, declined to Rs.5,800/- on 4th thereafter expressed a declining trend and reached Rs.5,250/- on 14th. The price which was Rs.5,250/- on 14th ruled steady till 28th, improved to Rs.5,300/- on 29th and closed at Rs.5,350/- with a net loss of Rs.550/- per quintal. The price of Rasi copra at Alappuzha market which opened at Rs.6,000/-per quintal also expressed a similar trend and closed at Rs.5,350/- with a net loss of Rs.650/- per quintal. The price of milling copra at Kozhikode market which opened at Rs.5900/- per quintal expressed a mixed trend and closed at Rs.5,400/- with a net loss of Rs.376/- per quintal. The monthly average price of Rs.5,422/- per quintal at Kochi market, Rs.5,525/- per quintal at Alappuzha market and Rs.5,524/- per quintal at Kozhikode market were 6 to 9 percent lower than that of the previous month and about 42 to 44 percent lower than that of the corresponding month last year. The monthly average price of milling copra at Kangayam market in Tamil Nadu was Rs.5,119/- per quintal, which was marginally lower than that of the previous month and about 46 percent lower than that of the corresponding month last year.

Edible Copra

The monthly average price of Rajapur copra at Kozhikode market was Rs.8,636/- per quintal, which was 17 percent lower than that of the previous month



Price behaviour of coconut oil during March 2016



Price behaviour of copra during March 2016

and about 39 percent lower than that of the corresponding month last year.

Ball Copra

The monthly average price of ball copra at Kozhikode market was Rs.7,580/- per quintal, which was 18 percent lower than that of the previous month and about 40 percent lower than that of the corresponding month last year.

The monthly average price of ball copra at Tiptur APMC market in Karnataka was Rs.8,311/- per quintal. This was 14 percent lower than that of the previous month and about 35 percent lower than that of the corresponding month last year. The monthly average price of ball copra at Arsikere APMC market in Karnataka at Rs.8,496/- per quintal was 13 percent lower than that of the previous month and about 30 percent lower than that of the corresponding month last year.

Dry Coconut

The monthly average price of Rs.6,656/- per thousand nuts at Kozhikode market was 19 percent lower than that of the previous month and about 44 percent lower than that of the corresponding month last year.

Coconut

The monthly average price of partially dehusked coconut at Nedumangad market at Rs.8,615/-per thousand nuts was 14 percent lower than that of the previous month and about 46 percent lower than that of the corresponding month last year.

The monthly average price of partially dehusked coconut at Arisekere APMC market in Karnataka was Rs.9,265/- per thousand nuts, which was marginally lower than that of the previous month and about 25 percent lower than that of the corresponding month last year.

The monthly average price of partially dehusked coconut at Bangalore APMC market in Karnataka was Rs.11,769/- per thousand nuts. This was seven percent lower than that of the previous month and about 28 percent lower than that of the corresponding month last year. The monthly average price of Grade-1 quality partially dehusked coconut at Mangalore APMC market was Rs.15,000/- per thousand nuts, which was marginally higher than that of the previous month and about 17 percent lower than that of the corresponding month last year.

Tender coconut

The monthly average price of tender coconut at Maddur APMC market in Karnataka was Rs.10,000/- per thousand nuts. This was marginally lower than that of the previous month and six percent higher than that of the corresponding month last year.

International

The International monthly average price of coconut oil during the month of March 2016 at Philippines (C.I.F. Rotterdam) market was US$ 1343 per MT. This was about 11 percent higher than that of the previous month and about 22 percent higher than that of corresponding month last year. The monthly average price of US$ 893 per MT of copra was 10 percent higher than that of the previous month and 24 percent higher than that of the corresponding month last year.

The domestic price of coconut oil during the month of March 2016 in Philippines was US$ 1322 per MT and in Indonesia the price was US$ 1369 per MT. The international price of Palm oil was US$ 623 per MT, Palm kernel oil (RBD) US$ 904 MT and Soybean oil US$ 779 per MT.

Prices of coconut oil , copra and coconut at various marketing centres during February 2016

Date	Coconut Oil (₹/Qtl)				Milling Copra (₹/Qtl)					Edible Copra (₹/Qtl)	Ball Copra (₹/Qtl)				Dry Coconut	Coco-nut	Partially dehusked Coconut (₹/1000 nuts)		
	Kochi	Alappu-zha	Kozhi-kode	Kan-gayam	"Kochi (FAQ)"	Alappu-zha (Rasi Copra)	Kozhi-kode	Kan-gayam	Amba-jipeta	Kozhi-kode	Kozhi-kode	Tiptur	Ban-glore	Ar-sikere	Kozhi-kode	Nedu-man-gad	Ar-sikere	Banglore	Mangalore (Grade-1)
06.03.16	9040	8640	8950	7473	5845	5960	5838	5340	5000	9475	8350	9164	13000	9420	7400	10000	9100	11500	15000
13.03.16	8540	8442	8717	7089	5455	5667	5650	5117	5000	9333	8183	8617	13000	8733	7100	10000	8950	11500	15000
20.03.16	8200	7700	8417	7000	5250	5300	5400	4983	5000	8000	6983	7696	13000	8000	6383	10000	9983	11917	15000
27.03.16	8200	7600	8400	7033	5250	5340	5380	5010	4800	8000	7040	7700	13000	7900	6100	10000	9160	12000	15000
31.03.16	8275	7650	8400	7033	5325	5338	5388	5188	4800	8500	7475	8475	13000	8475	6350	1000	9000	12000	15000
Average	8448	8025	8568	7123	5422	5525	5524	5119	4931	8636	7580	8311	13000	8496	6656	8615	9265	11769	15000

Source: Kochi: Cochin Oil Merchants Association and Chamber of Commerce, Kochi - 2, Kozhikode: The Mathrubhumi daily Alapuzha: The Malayala Manorama daily, Arsikere : APMC, Arsikere
Price quoted for office pass copra at Kozhikode and Rasi copra at Alappuzha markets.