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NEWS LETTER

OIL TECHNOLOGISTS' ASSOCIATION OF INDIA
WESTERN ZONE

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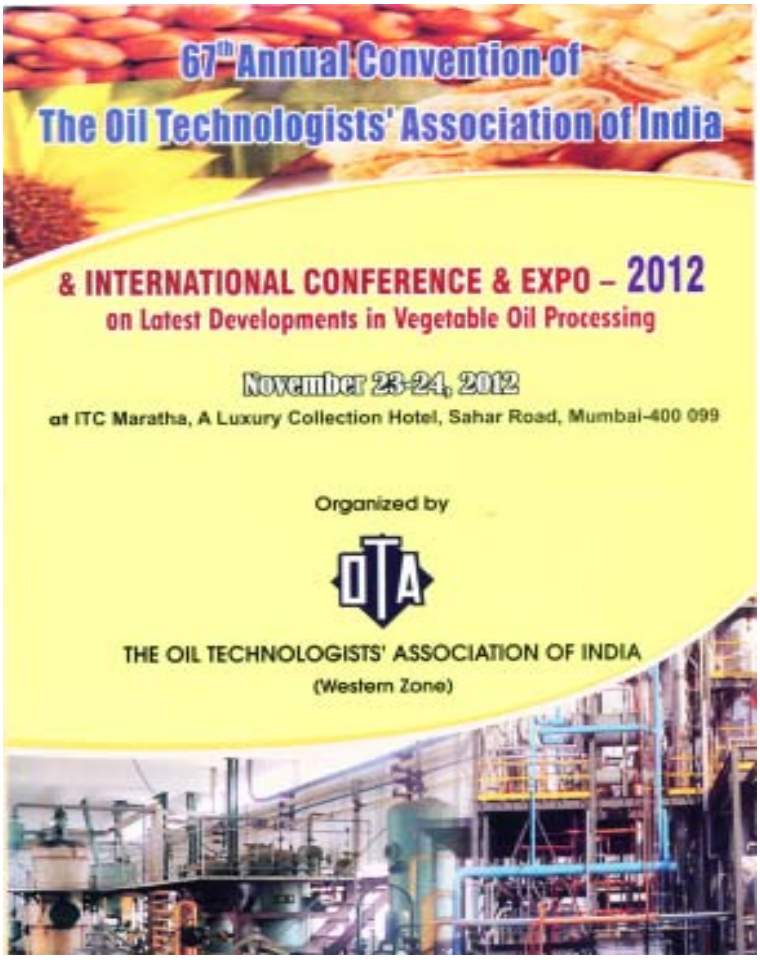

This news letter is for free circulation only to the members of OTAI-WZ

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OIL TECHNOLOGISTS' ASSOCIATION OF INDIA WESTERN ZONE

From the Editors's Desk

Come November. Come exciting times. OTAI West Zone will be unveiling thrilling developments in Oils and Fats industry. Will discharge responsibility to further the growth of edible oils in all its aspects - from the field storage, processing skills, saving losses, protect environment - determined adventure to mobilise skills to bring edible oils to the doorsteps of millions of Indians. Try to lower the yoke of imports in times to come. Youthful response all around expected. Come one, come all.

Share your expertise. Be a proud Indian.

"FOOD FOR THOUGHT"

Attaining agriculture growth by dint of Economic Survey

Agriculture has been a way of life and continues to be the single most important livelihood of the masses. Agriculture including allied activities, accounted for 14.5 percent of gross domestic product (GDP) at 2004-05 prices in 2010-11. Hence, reasonable growth in agriculture is important both from the nutritional point of view as well as to control food prices and overall headline inflation. Following are the ways and methods of achieving agriculture growth.

AGRICULTURAL INPUTS

IMPROVEMENT in yield, which is a key to long-term growth, depends on a host of factors including technology, use of quality seeds, fertilizers, pesticides, micronutrients, and irrigation. Each of these plays a role in determining yield level and in turn augmentation in the level of production.

Seeds

Good quality seed is one of the most important inputs for enhancing agricultural productivity and production. Efficacy of other agricultural inputs such as fertilizers, pesticides, and irrigation is largely determined by it. Seed quality is estimated to account for 20-25 per cent of productivity. It is, therefore, important that quality seeds are made available to the farmers. Since the year 2005-06, the central government has been implementing a central-sector scheme known as 'Development and Strengthening o f Infrastructure Facilities for Production and Distribution of Quality Seeds' to address the gaps in infrastructure and to increase availability of quality seeds for different crops through various interventions. The objective of the scheme is to ensure production and multiplication of high-yielding certified/quality seeds of all crops in sufficient quantities and make them available to farmers at affordable prices. An amount of '1987.83 crore (till 15 February 2012) has been released as grants-inaid under different components of the scheme. Although this scheme has contributed to doubling the availability of quality seeds in the last five years, it requires major changes and upgradation to meet the challenges of the rapidly evolving seed sector and ensure wider use of quality seeds. Accordingly, a National Mission on Seeds for the Twelfth Plan Period has been proposed. The New Policy on Seed Development (NPSD) was formulated way back in 1988 with a view to providing the best planting material available abroad to Indian farmers. The policy has, over the years, facilitated import of seeds under various categories. The policy permits initial import of small quantities of seeds of cereals, oilseeds, pulses, etc. for in-house trial by the importer. Based on satisfactory results of multi-location trials, importers are permitted to import in bulk. Subsequently, NPSD 1988 was revised to allow import of seeds of wheat and paddy, coarse cereals, pulses, and oilseeds under prescribed conditions. The revisions in NPSD could usher in an enabling environment for speedy trial and

evaluation of seeds, thereby facilitating timely imports. In response to the changes that have taken place in the seed sector, the Seed Act 1966 is proposed to be replaced by a suitable legislation to-

(i) create an enabling climate for growth of the seed industry,

(ii) enhance the seed replacement rates,

(iii) boost export of seeds and encourage import of useful germplasm and

(iv) create a conducive atmosphere for the application of frontier sciences in variety development and enhanced investment for R&D.

Presently, the Bill is under consideration for moving official amendments to it based on suggestions received from various quarters. FDI policy for agriculture sector was amended to allow 100 per cent FDI under automatic route for 'development of seed'. Earlier, FDI was permitted for 'development of seed under controlled condition'.

Mechanization and Technology

Farm mechanization has immense potential for improving farm productivity. Empirical data reaffirm that availability of farm power has a direct correlation to agricultural productivity. Appropriate crop and region-specific agricultural equipment enable efficient utilization of farm inputs making farming viable and attractive. Though the country has been witnessing considerable progress in farm mechanization, its spread across the country still remains uneven. Current farm power availability hovers around 1.7 kw/ha which is much lower than that of Korea (7+ kw/ha), Japan (14+kw/ha), the USA (6+kw/ha). It is estimated that in order to upscale farm productivity so as to grow more food given the stagnant net sown area, farm power availability must reach at least 2.0 kw/ha by the end of Twelfth Five Year Plan. Gradual increase in farm mechanization will also help release agricultural labour for other emerging and valued sectors, thus contributing more towards GDP. So far in India, 'tractors' have been the major symbol of agriculture mechanization. Indian agriculture is dominated by small and marginal farmers, whose smaller landholding and weaker economic status render single ownership of much high-value agricultural machinery and equipment. In this context, supporting and franchising rural entrepreneurs for establishing custom hiring or farm service centers will help extending benefits of farm mechanization to so far 'excluded farmers' category.

Fertilizers

India is meeting 80 per cent of its urea requirement through indigenous production but is largely import dependent for meeting the requirements of potassic (K) and phosphatic (P) fertilizers. Chemical fertilizers have played a significant role in the development of the agricultural sector. Consumption of chemical fertilizers has steadily increased over the years.

The Nutrient Based Subsidy (NBS) Policy for fertilizers was implemented in 2010. Under the NBS Policy, a fixed subsidy is announced on per kg basis of nutrient annually. An additional subsidy is also given to micro-nutrients. With the objective of providing a variety of subsidized fertilizers to farmers depending upon soil and crop requirements, the government has included seven new grades of complex fertilizers under the NBS. Under this scheme, manufactures/marketers are allowed to fix the maximum retail price (MRP). Farmers pay only 50 per cent of the delivered cost of P and K fertilizers, the rest is borne by the Government of India in the form of subsidy.

Irrigation

Irrigation is one of the most important inputs required at different critical stages of plant growth of various crops for optimum production. The Government of India has taken up augmentation of irrigation potential through public funding and is assisting farmers to create potential on their own farms. Substantial irrigation potential has been

created through major and medium irrigation schemes. The central government initiated the Accelerated Irrigation Benefit Programme (AIBP) from 1996-97 for extending assistance for the completion of incomplete irrigation schemes. Under this programme, projects approved by the Planning Commission are eligible for assistance. Under the AIBP, 50,380.64 crore of central loan assistance (CLA)/grant has been released up to 30 November 2011. As on 31 March 2011, 290 projects were covered under the AIBP and 134 completed. During 2010-11, an irrigation potential of 566.24 thousand ha is reported to have been created by states, from major/medium/minor irrigation projects under the AIBP. While the higher irrigation potential would help augment production and productivity, assured remuneration from such production is vital for development of agriculture.

MAJOR SCHEMES/PROGRAMMES IN THE AGRICULTURE SECTOR

Agriculture being a state subject, the primary responsibility for increasing agriculture production, enhancing productivity, and exploring the vast untapped potential of the sector rests with the state governments. However, in order to supplement the efforts of the state governments, a number of centrally sponsored and central-sector schemes are being implemented for enhancing agricultural production and productivity in the country and increasing the income of the farming community.

National Food Security Mission (NFSM)

The NFSM, launched in 2007, is a crop development scheme of the Government of India that aims at additional production of 10, 8, and 2 million tonnes of rice, wheat, and pulses respectively by the end of 2011-12.The scheme was approved with an outlay of 4,883 crore for the period from 2007- 08 to 2011-12. A sum of about 3,381 crore has been spent till 31 March 2011. The Mission interventions consist of a judicious mix of proven technological components covering seeds of improved variety, soil ameliorants, plant nutrients, farm machines/implements, and plant protection measures. In addition, a special initiative under the name of the Accelerated Pulses Production Programme was initiated in 2010 to boost the product ion of pulses by active promotion of technologies in 1,000 clusters of 1,000 ha each. Considerable achievements under the NFSM have been recorded during the course of implementation of the programme such as new farm practices, distribution of seeds of high yielding varieties of rice, wheat, pulses, and hybrid rice, and treating area with soil ameliorants to restore soil fertility for higher andproductivity. Through targeted interventions, the mission has already achieved, a year in advance, 25 million tonnes of additional production of food grains exceeding the target of 20 million tonnes of production set for the terminal year 2011-12, of the Eleventh Year Plan.

Integrated Scheme of Oilseeds, Pulses, Oil Palm, and Maize (ISOPOM)

Oilseeds are raised mostly under rainfed conditions and are important for the livelihood of small and marginal farmers in the arid and semi-arid areas of the country. The centrally sponsored ISOPOM have been under implementation during the Eleventh Plan in 14 states for oilseeds and pulses, 15 for maize, and 9 for oil palm. The pulses component has been merged with the NFSM with effect from 1 April 2010.

Rashtriya Krishi Vikas Yojana (RKVY)

The RKVY was launched in 2007-08 with an outlay of 25,000 crore in the Eleventh Plan for incentivizing states to enhance public investment to achieve 4 percent growth rate in agriculture and allied sectors during the Eleventh Five Year Plan period. The states have been provided 14,598.31 crore under the RKVY during 2007-08 to 2010-11. Allocation under the RKVY for the current year is 7,810.87 crore. The RKVY format permits taking up national priorities as sub-schemes, allowing the states flexibility in project selection and implementation. The sub-schemes include Bringing Green Revolution to Eastern Region; Integrated Development of 60,000 Pulses Villages in Rainfed Areas; Promotion of Oil Palm; Initiative on Vegetable Clusters; Nutri-cereals; National Mission for Protein Supplements; Accelerated Fodder Development Programme; Rainfed Area Development Programme; and Saffron Mission. The RKVY links 50 per cent of central assistance

to those states that have stepped up percentage of State Plan expenditure on agriculture and allied sectors. States have indeed increased allocation to agriculture and allied sectors from 4.88 per cent of total State Plan expenditure in 2006-07 to 6.04 per cent of in 2010-11 (Revised Estimates—RE).

National Horticulture Mission (NHM)

The horticulture sector includes a wide range of crops, such as fruits, vegetables, roots and tuber crops, flowers, aromatic and medicinal plants, spices, and plantation crops, which facilitate diversification in agriculture. It has been recognized that growing horticulture crops is now an ideal option to improve livelihood security, enhance employment generation, attain food and nutritional security, and increase income through value addition. Over the years, there have been noticeable achievements and significant improvement in the production and productivity of various horticulture crops.

The NHM scheme was launched during the Tenth Plan for holistic development of the horticulture sector, duly ensuring forward and backward linkages by adopting a cluster approach, with the active participation of all the stakeholders. At present, 372 districts in 18 States and 3 UTs have been covered under the NHM. The supply of quality planting material through establishment of nurseries and tissue culture units, production and productivity improvement programmes through area expansion and rejuvenation, technology promotion, technology dissemination, human resource development, creation of infrastructure for post-harvest management and marketing in consonance with the comparative advantages of each state/region and their diverse agro-climatic conditions are the major programmes of the Mission. A major initiative has been taken during 2011-12 for enhancing the supply of good quality vegetables to metro cities under the Vegetable Initiative in Urban Clusters.

Macro Management of Agriculture (MMA)

The MMA Scheme was revised in 2008 to improve its efficacy in supplementing/complementing the efforts of the states towards enhancement of agricultural production and productivity. It also provides opportunity to draw upon agricultural development programmes out often sub-schemes relating to crop production and natural resource management, and give it the flexibility to use 20 percent of resources for innovative components. The revised MMA scheme has formula-based allocation criteria and provides assistance in the form of grants: loan to the states/UTs on 90:10 ratio basis, except in case of the north-eastern states where the central share is 100 per cent grant. Out of the total outlay for the Eleventh Plan, i.e. 5,500 crore, funds to the tune of 3,845 crore have been utilized/released to the states/UTs during the first four years of the Plan period. An outlay of 780 crore has been approved for 2011-12, out of which an amount of' 772 crore has been released to states till 21 February 2012.

(Courtesy : National News Service (NNS), Business Star, May 2012)

"TITANS MEET"

Bill Gates meets Remo Pedon in Ethiopia to familiarize with ACOS

RECENTLY, a meeting took place in Ethiopia between Bill Gates, Microsoft founder and Remo Pedon, Managing Director of the Molvena based in pulses processing and closely linked to the humanitarian work by CRS (Catholic Relief Services) and the Gates foundation. Pedon recollects that "When we started in 2005 there were no such things as infrastructure and logistics, farmers used to knock daily at our doors asking to sell beans in order to send their kids to school. Nowadays, we operate through ECX (Ethiopian Commodity Exchange) and we load and seal contain-

ers at our site. We also have a school started for our employees' kids which has now grown to 300 pupils and is now open to all. We offer free education and school bus transfers for those coming from far afield. Additionally, we offer a fully catered canteen on site. Ethiopia is a country of stunning beauty, its people are kind and open hearted and repay you with the warmest of smiles."

ACOS has been the first European company of its sector to invest significantly in Ethiopia and the credit goes to the liberalization policy developed by the local government. Today ACOS is recognized as the role player in Ethiopia serving clients such as Princes, Unilever, Bonduelle, Conserve Italia, Coroos, Tiger Foods, Goya group the world over. Similarly, it has become the main reference partner in Ethiopia for CRS, Catholic Relief Services, the official international humanitarian agency established in 1943 of the Catholic community in the United States. The NGO alleviates suffering and provides assistance to 100 million people in need in nearly 100 countries worldwide. About 94% of donations goes to funding towards support and assistance projects overseas (918 million Euro in 2010). ACOS is indeed CRS's partner in Ethiopia supporting small, local navy pea bean farming at every level. Practically, it upgrades the capacity and competitiveness of Ethiopian white pea bean smallholders to increase their income and food security and strengthen value chain links between informal smallholderfarmers and formal markets. Mr. Gates, who has donated nearly $ 2 billion to food security in the past decade and plans to give another $2 billion in the next five years, told an audience of the three agencies in Rome that the current system was "outdated and inefficient." Mr. Gates also blamed western nations for some of the failures of the UN agencies that specialize in agriculture and food security, stating "many donors and agencies do not work together in a coordinated manner to give aid to small farmers needing it, when they need it most." Currently, Gates foundation supports 125 empowerment smallholders' projects to enter formal economic markets. Remo Pedon's ACOS Ethiopian project is an essential part of the process; navy pea beans are not consumed in the internal market and become an important income source for small, local farmers. ACOS leads the field as main Ethiopian navy pea bean exporter with a 70% market share. Besides Ethiopia, ACOS is situated China, Mexico, Argentina, Canada, Egypt, Turkey and USA.

(Courtesy : National News Service (NNS), Business Star, May 2012)

"SOYA AHOY"

India's soya meal exports improved slightly in 2011-12

INDIA's Soy meal exports, which constitute a major part of oilmeal exports, went up by 12.69 percent to 4,61,892 tonnes in March 2012 from 4,09,882 tonnes a year earlier. The annual Soy meal exports in the financial year 2011-2012 (April-March) were 39,14,683 tonnes, marginally higher by 1.79 percent from 38,45,736 tonnes a year ago. During the FY 2011-12 export to Iran, Thailand, Japan, EU and Mozambique (Africa) registered exceptional growth. However, export to Vietnam; Indonesia and UAE were hit due to certain trade barriers. Partially, export of Soybean Meal suffered during last quarter (Q4) due to poor availability of soybean & corresponding lower crushing. During the first half of current Oil year (October -September), exports during October'11 to March'12 were 27,85,831 MT as against 29,97,847 MT last year reporting a drop of 7 percent.

(Courtesy : National News Service (NNS), Business Star, May 2012)

"SPICY ROUTE"

India plans to surge exports through spices parks

INDIA is the world's largest producer and exporter of spices. With plantations spreading over several million hectares across the length and breadth of the country, India exports around 180 kinds of spices to nearly 150 countries worldwide. Thus, it plans to set up 10 spices parks across the most strategic locations in the country by end of 2012 in an effort to promote exports of spices from India. The project is being executed by the Spices Board at a capital cost of Rs 167 cores and out of which around Rs 75 crores have already being invested in three completed spices parks in Chhihdwara in MP, Puttady in Kerala and in Jodhpur in Rajasthan state. The other parks will be completed during the year in states like Andhra

Pradesh, Tamil Nadu, Madhya Pradesh and Kota in Rajasthan. The Spices Board has completed the construction of Spice Park in Rampura Bhatia Village of Ozian Tehsil near Jodhpur in an area of 60- acres provided by the Rajasthan Government and was inaugurated by Mr. Anand Sharma, Union Minister of Commerce & Industry and Mr. Ashok Gehlot, Chief Minister of Rajasthan. The park has common infrastructure and processing facilities for the seed spices especially cumin and coriander. A public private partnership is ensured with 17 exporters to set up state of the art processing lines and also cold storage facilities and also facilities to produce oils and oleoresins from seed spices. The machineries in the Park are capable for the processing of other seed spices like fennel and fenugreek, which are quite ample in this region. A full line processing facility with a capacity to turn out two tones per hour has inbuilt facilities for pre-cleaning, grading, colour sorting, grinding and packing. The Spice processing facilities available at Spice Park are at par with the international standards. The higher end processing plants installed is a full processing line which includes pre cleaning, grading, colour sorting, grinding and both bulk and consumer packing ranging from 100 g to 50 Kg. The Board is establishing a sterilization facility within the plant building with a capacity of 250 Kg per hour in batch process. The Board will also be allotting individual slots for exporters on lease basis for developing their own processing plants in the Parks. There was tremendous response from the exporters who wanted to set up their own facilities in the Park. The Spices Board has set up other common infrastructures like Compound wall, Road, Drains, Water Distribution system, Power Station, Weighing Bridge, Common parking area, Truck yard, Warehouses, preliminary Quality Testing facility, Bank counter, Training centre, Conference Hall, Canteen facilities etc . within the Parks.

According to reports, the Spice exports increased 0.94% in the April-January period of the Fiscal 2011-12. A total of 436,175 tons of shipped in the first 10 months of the year and is valued at Rs 7,849 cr as compared to 432,115 tons valued at Rs 5,354 cr in the same period of the previous financial year. India which exports spices to Singapore, South Africa, Canada, UAE, Sri Lanka, Saudi Arabia, France, Malaysia, Netherlands, and Nepal is all set to boost its exports.

(Courtesy : National News Service (NNS), Business Star, May 2012)

EXCITING TIMES !

Asian oleochemicals sector attractive for companies willing to invest in new technology, mergers, and acquisitions

KONGKRAPAN INTARAJANG

Companies that invest in new technologies or grow through mergers and acquisitions will emerge as winners in the buoyant Asian oleochemicals sector.

THE oleochemicals industry in Asia should benefit from a global recovery that has broadened, in today's terms, to encompass more firms, countries, and components of aggregate demand.

Better labor market conditions in high-income countries and increasing domestic demand in developing countries bode well for a continued global recovery that has been going on for almost two years. Overall, global growth is projected to ease from 3.8% in 2010 to 3.2% in 2011, as lingering post-crisis difficulties in the United States and the European Union (EU) continue to pose downside risks, with ripple effects expected throughout 2012.

Developing economies, on the other hand, should expand by at least 6.3%, reflecting an end to bounce-back factors that served to boost growth in 2010 and the tightening of monetary and fiscal policies as capacity constraints increase.

Closer to home, the Association of Southeast Asian Nations (ASEAN) economic community is set to spur member countries' economic growth beyond 2015 as Southeast Asia is forecast to lead recovery. Domestic demand within East Asia and the Pacific is forecast to continue its domination in the Asia Pacific region until 2013. Intra-region

trading, driven by strong internal demand in China and India, will further propel East Asian and Pacific growth rates, superseding the world average.

Market drivers

The oleochemicals industry is unique in that, despite the market volatility seen by most commodity-based business in the last decade, it has benefitted from an increasingly mature and growing market. New applications, innovation, and demand for sustainable solutions have taken center stage.

Fueled by a hike in demand from a growing consumer market and wider availability of raw materials such as palm oil, palm kernel oil, and coconut oil, the oleochemical industry in Southeast Asia— the world's leading oleochemicals manufacturing hub—is expected to enjoy strong growth into 2012.

Here, oleochemical production is mainly centered on the manufacture of fatty acids, fatty alcohols, methyl esters, and refined glycerin. These then go into end-use applications of surfactants, soaps and detergents, cosmetics, food emulsifiers, paints and inks, and lubricants. Offering many advantages to oleochemical players—such as abun-nt raw material supply, lower manpower costs, and improving infra-ucture— key market drivers for the industry at large include the lowing:

Rationalization and consolidation opportunities. Downstream inte-ition by large plantation companies that aim to capture additional lue from their control of the key vegetable oil resources took the id in consolidation efforts in 2008 and 2009, seizing opportuni-s in Europe and North America. Reduced profitability, low interest :es, and capacity overhang worldwide provided room for acquisi->ns and consolidations in 2010. Industry players became more ver-:ally integrated and better suited to leverage market drivers such as :hnological advancements and establishing market presence through nsolidation. Improved earnings stability is now within reach.

Growing and maturing markets. Rising consumer demands for :>ric, home, and personal care products in Asia and Latin America ; major drivers supporting growth. Demand in Southeast Asia for rivatives is spurred by the detergents, personal care, industrial, food, d fuels markets. This is encouraged by population growth, expand-g middle class, increased focus on sustainability, and the buildup of frastructure, particularly in China and India. As China strives to be lf-sufficient, India's oleochemicals demand will continue to increase the compound annual growth rate of more than 7%. Oleochemi-I manufacturers will benefit from rising consumption as it fuels the

•velopment of pharmaceuticals and plastics.

Raw materials. Overall, 2010 saw a healthy oleochemical market rformance, but feedstock volatility continues to pose a challenge, anetheless, Asian palm plantation companies are expected to do :11, as they continue to vertically integrate their operations and invest ore in downstream processing of their feedstocks. Burgeoning palm antations in Malaysia and Indonesia give the ASEAN region a pre->minant supply position in the vegetable oil industry, leading the eochemical industry's recovery momentum with Southeast Asia ane to produce about 3.5 million metric tons in 2010.

Green chemistry. Stimulated by increasing demand for green lemicals and uses in new applications such as biolubricants, green lemicals, bioplastics, and biopolymers, industry players have further vested to advance product offerings in the high-value derivatives gment. Consumer interest in renewable and sustainable products is jositive trend, with growing environmental push to provide products at are comparable with petrochemical-based solutions.

Just over two decades ago, Asia Pacific had no place on the eochemical map. Almost 90% of the world's production of fatty ids and alcohols, and virtually 100% of all the other basic oleochemi-1s, were produced in developed countries such as the United States, irope, and Japan. Today, the majority of global fatty acid expansion centered in Asia while demand for fatty acids in the United States id Europe will be supplied via a combination of tallow- and palm based material.

Market constraints

Production and overhead costs will be significantly affected in the next ro to three years as raw material and energy prices may remain high, luting the profits of market participants. With the

rapid development the chemical industry and the surge in the biodiesel industry, raw aterial prices have continued to be extremely volatile.

The production of chemicals from refining and distillation pro-isses consume high amounts of energy, adding to overhead costs. Managing this in the larger business strategy remains key to profitability, as well as managing the entire carbon chain.

The region's oleochemicals market shows a trend toward polarization. Local players that lack investment or a partner to develop downstream products remain on the commodity side in oil production. But firms investing in advanced technology, equipment, and high-end production in Southeast Asia join forces with specialized partners to grow in presence and provide more solutions in areas such as anionic surfactants, personal care raw materials, food processing, and fatty acids.

Critical to long-term viability, oleochemical business strategies must be able to: (i) identify, create, and leverage growth segments; (ii) systematically improve production and distribution efficiencies; and (iii) emphasize product quality and consistently innovate to drive product improvement and development.

Given that there are a limited number of end-customers, developing the right economies of scale and growing to a right size will ensure sustained business, as even large-scale players are expected to witness a downward trend in revenues due to intense competition in the market. Forming strategic alliances that allow players to tap economies of scale and supplies of raw materials with plantation companies could prove to be a preferred route for the industry.

Key success factor

Many chemical companies are investing resources to further their .participation in the "green" dialogue, as renewables and sustainability become more relevant to consumers. Product innovation in this space is anticipated as oleochemical players devise ways to enhance product performance of even existing solutions that remain largely untapped. One such example is methyl ester sulfonate, whose growth is propelled mainly by the surfactant market because of its higher biodegradability and environmentally friendly characteristics.

More stringent environmental regulations will most certainly affect the overall Southeast Asian chemical industry. Europe and China alike, both important markets for this industry, have taken measures to better control their exports of chemical substances. China's REACH regulation (where REACH means Registration, Evaluation, Authorisation and Restriction of Chemical substances), in force since October 2010, utilizes many of the measures of the EU's REACH and also incorporates unique provisions specific to the country.

While regulators seek to harmonize all these rapidly maturing regulations, they will invariably increase production costs and could delay the time-to-market.

Other regulatory moves, such as those outlined by the Round-table on Sustainable Palm Oil, will also have an effect on a company's value chain as everyone rallies to participate in the global "green" agenda.

Emery Oleochemicals is experienced in providing materials for plastic additives and bio-lubricants. Now we are working to widen our portfolio in the home and personal wellness and surfactant segments_ through investments and joint ventures.

(Courtesy : Inform February 2012, Vol. 23 (2))

MIXED RESULTS

Jatropha failing in Madagascar

GEM BioFuels planted 55,737 hectares of jatropha in Madagascar between 2007 and 2009. On April 12,2012, the company announced, "[A] lack of resources has resulted in significantly less success than had been hoped. Low intervention and maintenance following planting has resulted in a lower than anticipated number of plants reaching maturity and producing oil-bearing seeds." The board of directors of the company is now "determining a strategic plan to maximize the returns from its existing plantations, as well as how best to make use of the Company's significant presence in Madagascar for the production of other crops" (tinyurl.com/GEMjatropha).

The business, headquartered in Douglas, Isle of Man (UK), was founded in 2004 to capitalize on the opportunity presented by the local agricultural and socio-economic conditions in Madagascar to produce jatropha oil for use as a biodiesel feedstock.

(Courtesy : inform June 2012, Vol. 23(6))

"LOOK OUT"

Soy and hot flashes

A META-ANALYSIS of 17 clinical trials affirms that supplementation with soy isoflavones may reduce the frequency of and severity of meno-pausal hot flashes. Because there often is a significant placebo effect, some women taking isoflavone supplements "will likely see at least a 50% reduction compared to doing nothing," according to study co-author Melissa Melby of the University of Delaware (Newark, USA).

"The results from this comprehensive analysis show that soy isoflavones consistently alleviate hot flashes to a clinically relevant extent," said Mark Messina, another co-author. Messina is an adjunct professor at Loma Linda University in California (USA). "Further, the results provide justification for health professionals recommending that women wanting a nonhormonal alternative to estrogen for hot flash relief try isoflavones."

The meta-analysis - which is the largest and most comprehensive conducted to date, according to the authors - revealed that ingestion of soy isoflavones for six weeks to 12 months significantly reduced the frequency of hot flashes by more than 20% compared with placebo. Soy isoflavones also significantly reduced hot flash severity by more than 26% compared with placebo. The analysis found that the decrease in hot flash frequency in longer trials (more than 12 weeks) was approximately three times greater than the decrease in shorter trials.

Although a number of different isoflavones exist in nature, the three primary isoflavones in soy are genistein, daidzein, and glycitein. According to the authors of the study, isoflavone supplements providing higher amounts of genistein were approximately 50%-200% more effective at reducing hot flash frequency than isoflavone supplements containing lower amounts of genistein.

"Supplements providing a daily total of about 50 mg of total isoflavones will be effective as long as they also provide at least 19 milligrams of genistein," Messina noted.

Of the 17 studies included in the meta-analyses, 13 trials (including 1,196 women) evaluated hot flash frequency, and nine trials (including 988 women) evaluated hot flash severity. The study will appear in the July issue of Menopause (doi:10.1097/ gme.0b013e3182410159, 2012).

(Courtesy : inform June 2012, Vol. 23(6))

"NOT REALLY"

Do GM foods affect animal health?

A REVIEW that appeared in Food and Chemical Toxicology (50:1134-1148, 2012) assessed the health impact of genetically modified (GM) plant

diets in long-term and multigenerational animal feeding trials. The British and French authors examined 12 long-term studies (as short as 90 days, as long as two years in duration) and 12 multigenerational studies (from two to five generations). Diets contained GM corn, potato, soybean, rice, or triticale.

Biochemical analyses, histological examination of specific organs, hematology, and the detection of transgenic DNA were used to monitor the parameters of interest. Results from the 24 studies did not suggest any health hazards, and for the most part there were no statistically significant differences with the parameters observed. Some small differences were observed, but none fell outside the normal range of variation of the considered parameter. The reviewers concluded that the evidence they had considered showed that GM plants are nutritionally equivalent to their non-GM counterparts and can be used in food and feed safely.

The authors also suggested that, if required, a 90-day feeding study performed in rodents according to the OECD (Organisation for Eco-nomic Co-operation and Development) Test Guideline is generally sufficient to evaluate the health effects of GM feed.

(Courtesy : inform June 2012, Vol. 23(6))

"HOW"

Can water float on oil ?

THOUSANDS of years of conventional wisdom, starting with Aristotle, suggest that water cannot float on oil.

Now, however, scientists led by Chi M. Phan of Curtin University in Perth, Australia, report that in certain cases, the conventional wisdom is wrong. The discovery has important potential applications in cleaning up oil spills that threaten seashores and fisheries, they say.

Phan's team decided to test the idea that crude oil, with a density of about 58 pounds per cubic foot (about 0.93 grams per cubic centimeter)), cannot float on sea water, which has a density of 1.03 g/cm' using computer models in the lab.

They report that, in certain cases, the conventional wisdom is wrong. By adding tiny amounts of water to a floating droplet of oil, they found that the ability of water drops to float at the surface of an oil bath depends on both the size of the droplet and the type of oil. Commercial vegetable oil has enough surface tension at its interfaces with air and water to support a droplets weight, whereas pure mineral oils do not. At the same time, the researchers found that vegetable oil could not support drops bigger than about l/100th of a cubic inch (0.16 cm'). The authors suggest the new knowledge could help clean up oil spills, where water-borne, oil-eating microbes will mix more easily into the oil if suspended in the tiny droplets they describe.

"This result can lead to a new and advanced mechanism in processing oil/ water mixtures, such as biodegrading process of unwanted oils, including vegetable oils, sand oil tailings, and oil spillages," the authors said.

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GREAT NUT

Coconut oil: Science, Technology, and Applications

A.G. Gopala Krishna

The coconut (Cocosnudfem), which is one of the most important perennial sources of vegetable oil, has been consumed in tropical countries for thousands of years. Compared with all other oilseed crops, coconut is more productive, more consistently productive, and less susceptible to climatic variations. Of the 97 countries in which coconut palms are grown, Philippines, Indonesia, India, Vietnam, Mexico, Papua New Guinea, Sri Lanka, Malaysia, and Thailand produce almost 90% of the world's coconut oil.

THE total world production in 2010 of edible-grade coconut oil was 3.49 million metric tons (MMT). The three top-producing countries were Philippines, Indonesia, and India.Worldwide, 54% of the coconut oil sold is used for food, while the other 46% goes toward other uses. Coconut oil repre-

sents only 2.7% of the vegetable oils produced in the world, but from to country to country it varies from 0.3% of total production in Malaysia to 92.9% in the Philippines.

The relative percentages of coconut oil produced in each country that are used domestically for food vary from 100% in Sri Lanka to 11.0% in the Philippines.

In India, 57% of the coconut oil produced in the eastern coastal belt is used for food purposes. Wet coconut and its water are considered sacred by Hindus and are used for worship. Foods containing wet or dry coconut gratings are commonly used in a variety of daily food preparations and during festivities throughout the country.

Various countries have their own specifications for coconut oil, and the International Codex Alimentarius standard appears in Table 1.

Common methods of coconut oil production

Rotaries (rotating mortars and pestles) and expel-lers are used to crush dry coconuts (known as copra) and recover the oil. Different types of edible coconut oil are available: virgin coconut oil from wet coconuts (unrefined grade); coconut oil from dry coconuts (unrefined grade); and coconut oil that is produced by a solvent extraction method in which oil is extracted either from dry coconut or from the coconut expeller cakes and is refined, bleached, and deodorized. Virgin coconut oil is reported to have more health benefits than coconut oil extracted from copra.

Copra nulling by traditional method. The extraction of oil from copra is one of the world's oldest seed crushing operations. In India and Sri Lanka, copra is still crushed for oil extraction by primitive

TABLE 2. Codex Alimentarius standards for coconut oil"

Characteristic	Coconut oil
Color—platinum cobalt scale (max)	50
Relative density at 40°C and 20°C	0.908 and 0.921
Refractive index at 40°C	1.448-1.450
Moisture and other volatiles at 105°C (%)	0.1
Free fatty acids, calculated as lauric acid (% by mass, max)	0.3
Peroxide value (mequiv of active oxygen/kg)	<15
Iodine value (eg I /g)	6.3-10.6
Saponification value (mg KOH/g)	248-265
Unsaponifiables (max, g/kg)	=15
Reichert value	6-8.5
Polenske value	13 -18

** Codex Alimentarius (FAO/WHO), Codex Standards for Named Vegetable Oils, Codex Standard 210-1999. Codex Alimentarius, v-8-2001, Rome Italy, pp. 11-25.*

TABLE 3. Physicochemical characteristics of coconut oil

	Virgin coconut oil wet coconut	Unrefined from copra	Refined coconut oil
Appearance	Colorless	Slightly brownish	Colorless
Odor	Coconut smell	Coconut smell	Odorless
Melting point (°C)	24	24	24
Moisture (%)	<0.1	<0.1	<0.1
Iodine value (eg I_2/g)	9.1-15	7.5-15	7.5-12
Peroxide value (mequiv O_2/kg)	0-1	0-1	0-1
Saponification value (mg KOH/g)	245-255	245-255	250-255
Phospholipids (%)	0.1	0.1	0.0
Unsaponifiable matter (%)	—	0.42	0.19
Tocopherols (mg/kg)	150-200	150-200	4-100
Phytosterols (mg/kg)		400-1200	
Total phenolics (mg/kg)	640	618	20
Fatty acid composition (relative %)			
Saturates	92.0	92.0	92.0
Monounsaturates	6.0	6.0	6.0
Polyunsaturates	2.0	2.0	2.0

chekkus (fixed stone or wooden mortars in which rotating wooden pestles are powered by humans or animals) or in rotary ghanis (mechanically driven rotating mortars and pestles), expellers, and hydraulic presses. Conventionally, coconut oil is produced by expelling from dry copra, followed by refining during which the oil is heated to a high temperature. Both copra-based refined coconut oil and solvent-extracted, refined coconut oil have a bland odor and taste.

Wet coconut processing. In wet processing, wet coconuts are pressed to squeeze out the oil and coconut milk. The liquid is then processed further to produce virgin coconut oil.

Traditionally, virgin coconut oil is produced by a 24- to 36-hour fermentation of coconut milk that is expelled from freshly harvested coconuts. During this time, the oil phase separates from the aqueous phase. The resulting wet oil is then heated slightly for a short time to drive off the moisture and is finally filtered. The main disadvantages of this process are low oil recovery and fermented odor, which masks the characteristic coconut flavor of the oil.

In conventional methods for obtaining virgin coconut oil, freshly extracted milk is centrifuged to obtain cream, which is heated to 60-80°C (to coagulate the protein contained in the coconut milk) before centrifuging to obtain the oil.

At the Central Food Technological Research Institute in Mysore, India, virgin coconut oil is made by a new patented process of wet processing without heat, shear, or chemicals. The resulting oil is colorless, has a characteristic coconut flavor, and is used in several medicinal, cosmetic, and cooking applications. Philippines produces major quantities of virgin coconut oil, and it is also becoming popular in India, where an increasing number of processors produce it.

Comparison of oil produced by different processing methods

The fatty acid compositions of the oil extracted from copra via different extraction methods are similar.

Caffeic acid, p-coumaric acid, ferulic acid, and catechin have all been observed in coconut oil. The phenolic acid fraction of coconut oil prepared by boiling coconut milk (traditional coconut oil) is more complex than that of coconut oil prepared by pressing copra (commercial coconut oil).

The total phenol content of traditional coconut oil is nearly seven times higher than that of commercial coconut oil (618 ± 46 vs. 91 ± 11 mg kg '), suggesting that the phenol content varies with the extraction method. Coconut oil extracted under hot conditions (HECO) contains more phenolic substances (i.e., antioxidant activity) than that extracted under cold conditions (CECO). Therefore, the consumption of HECO may improve antioxidant-related health benefits compared with CECO.

Physicochemical characteristics of coconut oil

Coconut oil is insoluble in water. At temperatures above its melting point, it is completely miscible with most nonhydroxylic solvents such as light petroleum, benzene, carbon tetrachloride, and the like. In alcohol, coconut oil is more soluble than most common fats and oils. The oil is highly stable with respect to atmospheric oxidation (see Table 3 on page 396). The oil is characterized by a low iodine value, low unsaponifiable matter, low tocopherols content, high saponifi-cation value, and high saturated fatty acid content. Yet it is liquid at room temperatures of 27°C. On the other hand, a normal fat comprising long-chain saturated fatty acids (LCT) [such as—in Table 4—a trans fatty acid (TFA) fat containing 50% palmitic acid, 7-14% TFA or a medium-chain fatty acid (MCFA)-containing fat like coconut oil, which contains more than 50% MCFA] would be a solid with a melting point above 60°C. This is the difference between coconut oil and an LCT-containing fat such as a hydrogenated fat or a fat of tree origin (Table 4).

Medium-chain triglycerides (MCT) in coconut oil

Coconut oil is a source of MCT (that is, glycerol esterified with three fatty acids, each having a carbon chain 6-12 carbons in length) and consists of trilaurin (20.7-25.8%), caprodilaurin (17.2-21.4%), myristodilaurin (13.6-17.2%), laurodimyristin (7.4-10.2%),

lauromyristopalmitin (4.7-6.2%), and other minor triglycerides. MCT are a component of many foods, with coconut and palm oils being the dietary sources with the highest concentration of MCT.

Absorption and metabolism

MCT have a different pattern of absorption and utilization than the LCT that make up 97% percent of dietary fats. For absorption of LCT to occur, the fatty acid chains must be cleaved from the glycerol backbone by lipase. These fatty acids form micelles, are then absorbed and reattached to glycerol, and the resultant triglycerides travel through the lymph system en route to the bloodstream. Up to 30% of MCT are absorbed intact across the intestinal barrier and directly enter the portal vein. This allows for much quicker absorption and utilization of MCT compared to LCT. MCT are transported into the mitochondria independent of the carnitine shuttle, which is necessary for LCT-mitochondrial absorption. Oxidation of MCT provides 8.3 calories per gram, while LCT provides 9.2 calories per gram.

TABLE 4. Fatty acid composition" (%) of coconut oil (MCFA) and some other vegetable oils (LCFA and TFA)

Vegetable oils	Fatty acid chain length											
	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C18:1	C18:2	C18:3	C20:0	C22:0	Others
MCFA												
Coconut	7.0	5.4	48.9	20.2	8.4	2.5	6.2	1.4	—	—	—	
Palm kernel	—	1.2	51.6	22.9	12.2	1.3	10.8	—	—	—	—	—
LCFA												
Sunflower	—	—	—	—	6.3	3.0	43.7	47.0	—	—	—	
Rice bran	—	—	—	0.4	22.9	1.8	42.5	30.5	1.4	0.5	—	
Safflower	—	—	—	0.3	11.9	2.3	29.2	55.9	0.4	—	—	
Sesame	—	—	—	—	10.3	5.8	42.9	41.0	—	—	—	
Groundnut	—	—	—	—	14.0	3.8	41.9	34.7	1.0	1.2	3.4	
Palm	—	—	0.2	1.1	42.6	3.8	41.9	10.4	—	—	—	
Olive	—	—	—	—	12.0	2.5	75.7	7.9	0.5	—	—	1.4
Soybean	—	—	—	—	11.6	4.0	18.8	56.1	8.5	—	—	1.0
Grape seed	—	—	—	—	7.2	4.8	19.4	68.1	0.1	—	—	0.4
Linseed	—	—	—	—	7.1	2.0	19.9	17.3	53.7	—	—	0.4
TFA												
Hydrogenated fat	—	—	0.2	1.0 - 2.6	49.4 - 50.3	3.8	t7.2 - 14.4 C26.5 - 27.7	1.1 - 3.9	—	—	—	0.2

*MCFA, medium-chain fatty acids; LCFA, long-chain fatty acids; TFA, trans fatty acids, r, trans; c, cis.

Edible applications of coconut oil

Coconut oil has a high content of saturated fatty acids and hence is highly resistant to oxidative rancidity. Adding coconut oil to other vegetable oils improves their oxidative stability, indicating that coconut oil can be used as a natural antioxidant through the blending process. Adding coconut oil to safflower oil, sunflower oil, or rice bran oil increases the oxidative stability of the resultant blend. MCT have excellent keeping qualities and therefore help to increase the shelf-life of finished products. Coconut oil, along with other fats, is used to mimic human milk, and infant milk powders containing coconut oil have been developed.

Coconut oil is extensively used in food industries as a confectionery fat, particularly in the preparation of ice creams. In imitation chocolates, coconut oil is used in place of cocoa butter along

with cocoa powder.

MCT are ideal for treating the surfaces of crackers, as they act as a moisture barrier. They adhere well to surfaces, including metals. They are excellent release agents for surfaces that come into contact with food products or raw materials. These MCT can also be used as a glaze and polishing agent for confectionery products such as gummy-type candies. Solid MCT can help to enhance aeration properties in bakery products.

MCT are also available as a dietary supplement. They are essential nutrients for infants as well as for people with serious digestive problems such as cystic fibrosis because they are easily digested, absorbed, and put to use. Unlike LCT, they put little strain on the digestive system and provide a quick source of energy necessary to promote healing. Like other essential nutrients, one must get them directly from the diet.

Nonedible applications of coconut oil

One of the major nonedible applications of coconut oil is in the manufacture of soap; one important chemical derivative of coconut oil is methyl esters of coconut fatty acids, which are produced by treating coconut oil with methyl alcohol. These medium-chain fatty acid methyl esters (FAME) are important raw materials for the chemical industries, as they are easier to separate by fractional distillation than FAME comprising long-chain fatty acids.

Coconut oil has also been found useful for mixing with diesel. A 30:70 mixture provides excellent road performance in diesel vehicles. Methyl esters of coconut oil fatty acids are also being used as lubricants and biodiesel in the aviation industry.

Coconut oil has many other industrial uses in pharmaceuticals, cosmetics, plastics, rubber substitutes, synthetic resins, and the like.

Clinical applications of MCT and saturated fatty acids

The healing properties of coconut oil are due to antifungal and antibacterial activities. It kills bacteria that cause diseases such as pneumonia, sore throats, dental cavities, urinary tract infections, meningitis, gonorrhea, and food poisoning. It kills the causes of infections such as Candida, ringworm, athlete's foot, thrush, jock itch, and diaper rash. It also kills viruses having a lipid coating, such as herpes, HIV, hepatitis C, influenza, and mononucleosis.

Certain medium-chain fatty acids, such as lauric acid, have adverse effects on other pathogenic microorganisms, including bacteria, yeast, and fungi. These fatty acids and their derivatives actually disrupt the lipid membranes of the organisms and thus inactivate them.

Studies have also shown that short-chain saturated fatty acids can be used in the treatment of dental caries, peptic ulcers, benign pros-tatic hyperplasia, genital herpes, and cancer.

The preceding material shows that coconut oil can provide many health benefits. The scientific evidence needs to be generated so that consumers will accept it as a good oil although it has 92% saturated fatty acids and is different from a normal fat (i.e., fats of tree origin, hydrogenated fats, or hydrogenated vegetable oil) with 92% long-chain saturated fatty acids.

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Eight industry experts answer questions about enzymatic

Degumming

What are the economic benefits of using enzymes in oil degumming? How are they generated, measured, and validated on a plant scale? Is physical refining necessary to capture the most value?

Dayton: Economic benefits are generated by reducing neutral oil losses and adding value to the co-products (increasing the value by concentrating the tocopherols and producing a technical-grade concentrated fatty acid). Enzymatic treatment of the phos-pholipids yields recoverable diacylglycerols (DAG) and fatty acids and reduces the resultant heavy phase consisting of water and gums. That is, the amount and viscosity of the gums are reduced dramatically owing to their transformation into water-soluble compounds with few emulsification properties. In acid-degumming and/or caustic-refining processes, the whole phospholipid molecule is removed via emulsification. In the enzymatic process, only the lysophos-pholipids and/or phospho compounds are lost. Also, the amount of energy and chemicals used is reduced. The benefits of enzymatic processing may be validated by measuring: (i) the incoming oil volume and its phospholipid, DAG, and free fatty acid (FFA) composition; (ii) the DAG and FFA content of the outgoing oil; (iii) the neutral oil content of the generated heavy phase; and (iv) recovered tocopherols and fatty acids in the distillate following physical refining.

Enzymatically degummed oil should be physically refined to maximize the yield benefit. However, in a stand-alone extraction plant that exports its production, degumming using a phospholipase C (PLC) -/ enzyme will allow you to meet all specifications while increasing the oil yield.

Willits and Espinosa: Economic benefits include less neutral oil loss, less wastewater contamination, and lower maintenance as a result of free-flowing gums. The only sure way to measure these is through physical inventory changes in and out of the plant. For J degumming alone, physical refining does not make a difference. For a complete refining operation, enzymatic degumming followed by physical refining is most cost effective.

Carlson: The benefits are primarily yield gain and reduction of residual phosphorus (when this is desired, as in total degumming). We prefer to measure the gain by comparing the output of wet gums from the centrifuge over a specific time period. Obviously, the feedstock and processing parameters must be the same (except for temperature and addition of enzyme/caustic). In this case, the reduction in gums for enzymatic degumming can be directly translated to increased oil output. As for measuring residual phosphorus (especially in total degumming), we recommend inductively coupled plasma (ICP).

Cadore: The economic benefits include reduction in the overall volume of gums and consequent reduction in losses of neutral oil trapped in the gums. Also, gums from an enzymatic process (using either phospholipase C [PLC] or phos-pholipase A [PLA] as a processing aid) have less acetone-soluble content, that is, less fat. This means that the overall mass of gums and the percentage of oil present in the gums are reduced. When PLC is used as a degumming aid, yield is increased by conversion of phospholipids into DAG and phosphorus removal is enhanced. The best way to measure benefits at plant scale is to compare the amount of gums created during conventional water degumming with the amount of gums created with an enzymatic process. The reduction in total gums generated should correlate with an increase in levels on storage tanks and also the reduction in total fat in the meal.

Final conclusions on yield gain should be drawn only after weeks or months of operation, since process variations are always experienced whether using enzymatic or conventional degumming. The

use of analytical methods can give a very good indication of the benefits, but the efficiency of an enzymatic reaction is better validated by measuring the products for each type of enzyme used. Therefore, analytical methods serve well as a tool for process improvement and monitoring than as a yield measurement tool. In plants using PLC, DAG creation can be determined by using high-performance liquid chromatog-raphy, but plant managers should be aware that DAG creation is an indication of reaction efficiency. It does not necessarily mean that the benefits are being captured during the subsequent separation process.

Note that centrifuge adjustments are necessary to separate gums resulting from an enzymatic process, since they have slightly different physical properties (denser, less viscous) from those obtained with water degumming. The reduction of fat retained in the gums can also be taken into account when using analytical processes, and methods based on acetone solubility demonstrate the efficiency of the separation and enzyme reaction. The use of ICP to measure total phosphorus can also indicate the efficiency of reaction, especially in processes using acid pretreatment. For integrated soybean processing plants, removal of phosphorus (P)with enzymatic processes and recovery of FFA by physical means is the most economical in terms of operational costs. Enzymatic degumming can be used alone or in combination with physical refining. With degumming processes preceded by acid treatment, very low P levels can be achieved, the resulting oil may be physically refined into edible oil orbiodiesel, and overall losses are reduced compared to alternative methods. Plant managers should be aware that although enzymatic degumming followed by physical refining offers the lowest operational cost, it requires more upfront investment than conventional water degumming followed by chemical refining.

Vianna: For crude oil, DAG content may be increased by using PLC. For crude oil with lecithin production, using PLA may reduce losses. Enzymatic degumming can reduce the use of acid and caustic chemicals, the saponification of neutral oil, and effluent amounts while increasing yields and producing greater quantities ofadded-value products (e.g., tocopherols and FFA). Benefits are generated through fewer losses during separation. Because the enzyme reacts with phospholipids, it does not damage the neutral oil. Such benefits can be measured by mass balance using mass flow meters.

Physical refining enhances this benefit by recovering components such as tocopherol and FFA. While enzymatic degumming takes care of one oil impurity (phosphorus), physical refining takes care of the second impurity, FFA, in a more environmentally friendly way.

Curtis: Oil processors will never be fully aware of all the benefits of enzymatic degumming if they do not measure the right performance parameters of their current process. You need to assess input costs (e.g., oil from the extraction, energy, acid, and caustic) and output value of material produced (e.g., separated gums, meal cake, degummed oil, FFA, soapstock, etc.). The No. 1 driver for enzyme degumming is economics. When a process is pro erly monitored, we have heard reports as much as about 1% oil yield improv ment and even more when combinatio of enzymes are used. But there are oth potential economic, safety, and sustainab ity benefits such as reduced use of cherr cals, safer work environment, and redua generation of lower-value co-products../ these benefits can be realized whether yt are physically refining or simply producii and enzymatically degumming oil.

Which are the most important process variables that impact an enzyme's performance, and whal contaminants may reduce its activity? Can enzymes be applied to both crude and crude degummed oils?

Dayton: It is important to dry the cruc oil from the extraction process before enz matic processing. Otherwise, moisture w hydrate the hydratable phospholipids primarily phosphatidylcholine (PC) ar phosphatidylinositol (PI), causing the to foul the heat exchanger when the c is cooled down to a temperature that optimal for enzymatic activity. High-she mixing using an IKA' Dispax mixer wil 100-200 horsepower produces the emi sion needed for the enzymatic process' be successful (US patent 7,713,727). Oth variables include controlled citric ac: addition for dissociation of metals fro phosphatidic acid (PA), phosphatidyletl anolamine (PE), and

PI; controlled ba: addition for optimal pH of the enzyrm activity and selectivity; addition of ac after the enzymatic reaction (to reduce p prior to heating and separating, which pr vents fouling from calcium and magnesiu citrate; US patent 7,713,727); and add tion of silica and clay for zero phosphoru calcium, magnesium, and iron after silii treatment for physical refining.

No contaminants that will redui enzymatic degumming activity are know to be present in the oil. A combination PLC and PLA may be applied to both cruc and degummed oil (US patent applicatioi US 2008/0182322 and US 2008/094847 If single enzymes are used, PLC will m work on degummed oil due to the pri< removal of PC and PE.

Will its and Espinosa: The most important variables are quality of the water (soft water), strict control of pH, temperature, and quality of the mixer. Contaminants in the oil, such as citric acid and iron, reduce the enzyme's activity.

Enzyme degumming works for both crude and crude degummed oils. PLC is more effective on crude, and PLA is more effective on crude degummed due to the amount of non-hydratables present. Instrumentation and automation quality is also key.

Carlson: We have not experienced anything that negatively affects the enzyme. The critical issues are that the feed oil should be dry and cooled to the right temperature (55-60°C). In extraction plants with integrated degumming, the crude oil is not normally vacuum dried or cooled, as it goes directly to degumming. This is acceptable, as the oil can be hydrated (or acid-conditioned) at, say, 80°C, and any gums already precipitated in feed oil will come out in separation. However, if a wet oil is cooled, there is a risk that the precipitated gums will clog the cooler. Also, the enzyme will not work with already hydrated (precipitated) gums, which reduce yield gain.

Cowan: Water quality is important to achieve best performance. Chlorine content should be maintained as low as possible. pH control and the right temperature are also decisive when increasing performance.

Cadore: Each enzyme has an optimal pH and temperature range. Also, because enzymes are water soluble, there usually is an optimal concentration for each type of enzyme to ensure the most efficient reaction; this information should be supplied by the enzyme companies. These parameters must be achieved and, most importantly, stably maintained during operation. For instance, residual moisture from crude oil extraction can affect enzyme activity, particularly when there are wide variations.

The presence of metals (Ca, Mg, and Fe) in the hydration water and the pH of the water also require attention. In a process where we are trying to remove metals from the oil, the water used should be as free of metals as possible, and the pH of the water should be within the operating range indicated by the enzyme company.

Enzymes can be used for crude and for degummed oil. Phospholipases may be selective to certain types of phospholip-ids; therefore, it is important to know what phospholipids are present in the oil and select the appropriate type of enzyme for each application. Purifine" PLC is indicated for use in crude oils with high levels of phosphorus, since it reacts with two types of phospholipids that are only found in crude oil (PC and PE). In this case, enzymatic degumming can be used to minimize degumming losses and reduce the phosphorus content of crude oil to the standard of the trade (commonly 200 ppm for soy oil). PLA enzymes may react with all types of phospholipids, but they generate FFA as a product. Therefore, PLA may be better suited for removing P from oils that have been previously degummed with water.
Usually, in processes where enzymatic degumming is implemented, we can easily get to a lower phosphorus level compared to other degumming alternatives.

Vianna: Important process variables include oil moisture, oil quality, water quality, and process control and stability. Enzymes can be used for both crude and degummed oil.

Curtis: Fortunately, enzymes have a range of conditions where you get good performance. So you have some flexibility to optimize both the enzyme and your processing. This year, DSM launched Gumzyme', a specific subclass of phospholipase (PLA2) that operates at higher temperatures and

more nearly neutral pH. It also has an affinity for the less hydratable phospholipid species such as PA and PE. This gives you options, in addition to other enzymes in the market, when designing your total process. An enzyme for degumming is designed to help hydrate phospholipid species and improve their subsequent removal in the heavy phase. Therefore, you can use this process for any oil where you have phospholipids, including crude and crude degummed oils.

What storage conditions affect enzyme activity? What is the enzyme shelf life expected to be? Can enzyme activity be directly measured?

Willits and Espinosa: Temperature and light affect shelf life. With proper conditions, enzymes can be stored for several months from the time of manufacture. You have to follow the storage conditions suggested by the enzyme supplier. In some cases the temperature has to be below 10°C. These conditions are also important during transportation. You can measure the enzyme activity directly. It is possible to do this at the plant level.
Carlson: The activity of our enzyme, LysoMax' Oil, is measured by activity on a standard phospholipid (sourced from Sigma). A copy of the protocol for conducting the enzyme activity measurement is available on request. Customers can easily implement this assay in their labs.

Cowan: A good temperature for enzyme storage is 10°C. Transfer conditions must also be controlled to ensure enzyme quality. Enzyme activity can be controlled, but that is not critical if the proper storage conditions have been maintained correctly.

Cadore: Each manufacturer develops studies/experiments to determine the optimal storage conditions producing the longest shelf life for each of their products. As with any other biological product, enzymes degrade with time, especially if the recommended storage conditions are not observed. These storage conditions usually involve certain temperature ranges and avoiding exposure to direct light. Each manufacturer formulates its enzyme products to provide a specific activity and guarantees that the enzyme will remain above a minimum level of activity if storage conditions are met. Enzyme companies develop activity assays that are specific for each enzyme product, but they usually require lab apparatus, reagents, and analytical equipment not commonly found in plant labs, making it difficult to accurately measure activity onsite.

Vianna: Enzymes should be stored according to manufacturer's specifications. They normally need a cold room around 15-20°C.

Curtis: Generally, cooler temperatures will extend enzyme storage life. We recommend storage at 4-8°C for a one-year shelf life. However, we also know that enzymes can be shipped at ambient temperatures without loss of activity; so they don't need to be treated like an ice cream cone in the middle of summer. The important thing is to talk to your enzyme supplier for guidance. If you have expiring product in inventory, your supplier can usually test the activity. A natively, they can provide you with the lytical procedure to do it yourself or pu third-party testing. This same approach w allow you to test incoming products at discretion.

Are there any problems inherent to enzyme degumming, such as, tank bottoms? What other probl can be expected? How can these problems be solved?

Dayton: The calcium, magnesium, anc citrates that form when the dissociated n react with the citric acid present in the c an inherent problem. These salts will pr tate out of solution and foul any econorr heat exchangers, and the centrifuge in a; as one day. US patent 7,713,727 describ process for eliminating these salts.

Willits and Espinosa: There are no s cant unexpected problems associate! enzymatic degumming. If the process controlled, with good automation and the right size of mixer and reactor, you should not expect new problems with this technology.

Carlson: Our only comment is that, when using our enzyme, there is no more sedimentation in degummed oil than in normal water or total degumming.

Cadore: When comparing two identical degumming processes, one assisted by enzymes and the other not, the enzymatic process usually will provide oil with a lower total phosphorus level. Since there is a standard in the industry for trading degummed soy oil at 200 ppm P, plant managers may opt to adjust the centrifuges to allow for P to go into the oil phase up to the 200 ppm threshold. However, since the greatest portion of the P remaining in the oil phase is reacted P, this P has the tendency to precipitate really fast. This creates deposits on the bottom of storage tanks. So, when using a degumming process, plant managers should try to set up centrifuges to remove all reacted P, even if this means producing degummed oil with total P levels around 100 ppm.

When using PLA in crude oil, plant managers should be aware that the product of the PLA enzyme reaction is FFA. If one plant processes crude oil for export, there is a risk that this oil will easily exceed the maximum allowable threshold for degummed oil of 1% FFA. If a plant processes crude oil into edible oil/biodiesel and the removal of the FFA is done by physical means, the column must be designed to operate with the appropriate amount of FFA present in the oil coming into the column. These are not really problems, but characteristics of the enzyme, and the correct enzyme should be selected for each application.

Some enzymes function at low pH values, and often the pH is not corrected after the retention tank. Thus, oil with a very low pH goes into the heat exchanger and subsequently into the centrifuge for phase separation. The widely known problem of precipitation of calcium and magnesium salts of as a consequence of low pH can be easily overcame just by increasing the pH to near-neutral. This technique also makes the gums more fluid and consequently allows for a cleaner separation. Although sometimes this problem can be correlated with the use of enzymes, this is not a consequence of the enzyme reaction but simply of the pH of the process.

Vianna: If the separation step is not carried out properly, the reacted gums will precipitate in the tank. Also, if the moisture of the oil is not controlled properly, the heat exchangers may clog.

Curtis: We are not aware of any unanticipated problems with enzymatic degumming based on our experience with processors. If there are gums in your oil, you will have them falling to the bottom of tanks. So, the best solution is to optimize the process to ensure effective gum removal, but this is true for all processing.

Are there any health and safety issues in dealing with enzymes during processing? Are there any concerns on the safety of the processed oil?

Willits and Espinosa: No issues, no enzyme in oil, and the enzyme doesn't have activity in the by-products.

Carlson: When working with enzymes, you should always prevent skin contact by wearing gloves. Prevention of aerosol formation in the factory also is important. There are no health implications from the enzyme in the refined oil, because no enzyme is left in the oil. The enzyme will follow the gum, which, when added to the meal, is inactivated when the meal is heated above 100°C. Also, any minute amounts of enzyme left in oil will be denatured and removed in downstream processing.

Cowan: No issues are identified in relation to health. Customers should apply the right procedures to eliminate the enzymes before centrifugal separation. Enzymes are not toxic.

Cadore: Enzyme manufacturers issue Material Safety Data Sheets (MSDS), and plant operators should be aware of how to handle the product. Enzymes must go through rigorous processes to be certified for use in each country or region where they are sold. Enzymes are water soluble, and no traces of enzyme are found in the final oil product. Additionally, both oil and meal containing enzyme residues are submitted to high temperatures during processing that denature the enzyme. Any enzyme residues present in the meal will be broken down to their constituent amino acids with no effect on feed safety.

Curtis: As with any compound in the workplace, information about handling and safety precautions should be found on the MSDS. Generally, enzymes

do not pose a contact hazard to humans or equipment. Some enzymes are powders that, when airborne, can cause sensitization by inhalation.

Can the reacted gums be used for anything else, other than sending them to the meal? Can lecithin be produced when using enzymes for degumming?

Dayton: Currently, no commercial lecithin products are produced from enzymatic degumming owing to the destruction of the emulsification properties of the treated phos-pholipids and the presence of unwanted salts that would need to be removed in the case of PLA degumming. Several companies produce enzymatically treated egg lecithins for mayonnaise and heat-resistant lecithin, but not from the enzymatic degumming process.

PCT/US2009/000032 Generation of Triacylglycerols is a method of generating triacylglycerols from gums that are recovered from an oil-refining process. More particularly, this invention relates to an enzymatic process for the treatment of various phos-pholipids and lecithins (known collectively as "gums") from vegetable oils to produce, or "generate," triacylglycerols (triglycerides or oils).

Willits and Espinosa: There are no com mercial alternatives to meal application as of today. You cannot produce lecithin using enzymes.

Carlson: Potential markets for lyso gums are under investigation.

Cowan: Lyso gums can be used for other purposes. Oil from lyso gums can be recovered using a specific enzymatic process.

Cadore: Phospholipase enzymes by definition destroy phospholipids, which then become different molecules that no have the same emulsifying properties is what phospholipids are commonly! As of now, plants using enzymes as p ing aids during degumming/refining s incorporating the gums in the meal v advantage of having a reduced total; of gums to dilute the protein conten meal.

Vianna: The reacted gums can theoi be used, but there is no commercial developed. It is possible to produce and still use enzymatic degumming t PLA enzymes.

Curtis: Generally, the product kn lecithin would be changed if you wet enzymatic modification of the phos ids. However, since the enzymatic m tion of egg yolk phospholipids impro' emulsification properties, it would b looking at the functional properties matically modified phospholipids fr< etable oil production.

(Courtesy : inform February 2012, Vol. 23 (2))

EXCITING VENTURE

New program to boost camelina production

THE Risk Management Agency of the US Department of Agriculture (USDA) announced on November 30, 2011, a new pilot program of insurance for camelina growers. The program was made available to farmers in 41 counties in the state of Monta and 1 1 counties in North Dakota. The closi data for application to the program for t 2012 crop year was February 1, 2012.

Only spring-planted camelina gro\ under contract with a processor was eligit for coverage against damage from adver weather, fire, wildlife, earthquake, vole nic eruption, and insect and plant disea: The insurance will not provide compens tion for any losses attributable to insufficie or improper application of pest or disea control measures. Coverage levels offer* ranged from the catastrophic level to 65%.

Montana Senator Jon Tester inserts camelina insurance into the most recent far bill. He said, "There's got to be a safety m You don't go into new crops unless you': independently wealthy or you have a safe net."

Both Sustainable Oils (Bozemai Montana, USA) and Great Plains Oil Exploration-The Camelina Co. (Cincinnal Ohio, USA) offered contracts to Montar and North Dakota farmers to grow camelir in 20 12.

The USDA also offered a program i August 201 1 to encourage camelina plantin in the state of

Washington, but there were n takers (inform 22:560, 201 1). The failure c that program was attributed to the short tim available for the signup, federal budget cor straints, and farmer unwillingness to comm: to a new crop if it should happen to fail o produce insufficient revenue.

Camelina oil is being developed as feedstock for the production of aviation fuel.

(Courtesy : inform February 2012, Vol. 23 (2))

FLU ?

Lipid blocks influenza

A LIPID found in the fluid lining the lungs inhibits influenza infections in both cell cultures and mouse models, according to researchers at National Jewish Health hospital in Denver, Colorado, USA. These findings, combined with previous studies demonstrating effectiveness against respiratory syncytial virus, suggest that the compound, known as POPG (palmitoyl-oleoyl-phosphatidylglyc-erol), may have broad antiviral activity.

"Supplemental POPG could be an important, inexpensive, and novel approach for the prevention and treatment of influenza and other respiratory virus infections," said Dennis Voelker, professor of medicine and senior author of the report, published in the American Journal of Respiratory Cell and Molecular Biology (doi-.lO.ll6S/rcmb.2Q], 0194OC,201l).

(Courtesy : inform February 2012, Vol. 23 (2))

SAVE ENVIRON

Europe restricts phosphates

In December 2011, the European Parliament approved legislation to restrict the phosphate content of household cleaning products. The vote of 631-18 backed changes that had already been endorsed by European Union (EU) member states' representatives in November aimed at creating a common European phosphate standard, according to EurActiv.com, an online news site. National representatives still must formally approve the new legislation.

"By strictly limiting phosphorus in consumer laundry and dishwasher detergents, we have done the environment a good turn and consumers will be assured that these products will be more environmentally friendly," said UK Member of the European Parliament Bill Newton Dunn, the parliamentary leader on the legislation.

Although livestock waste is the main source of phosphorus in water supplies, farm fertilizers account for 16% and household detergents 10%, EurActiv noted.

If the legislation is formally approved, consumer laundry detergents will be restricted to no more than 0.5 grams of phosphorus per dose, beginning in June 2013. Automatic dishwasher detergents will be limited to a phosphate content of 0.3 grams per dose, as of January 2017. Although many companies offer alternative phosphate-free products, phosphates comprise up to half the weight of some detergents, EurActiv said.

"Many EU countries already limit the use of phosphates, but the EU measures will provide a common standard across the 27 countries, allowing simplified trade in soaps and detergents," the EurActiv report noted.

Also in Europe, the European Consumer Organisation and the European Environmental Bureau have published a joint position paper on the draft criteria for the EU ecolabel for laundry and dishwasher detergents for professional use, according to chemicalwatch.com.

The two groups were reported as saying in a statement that they "welcome improvements in the ecological criteria for laundry and dishwasher detergents" but emphasized that they "are not supporting broad exemptions from the list of banned hazardous substances and mixtures."

In the position paper, the groups recommend the exclusion of the presence of endocrine-disrupting substances and nanomaterials from Ecolabel

products, as a precautionary measure, chemicalwatch. com said. The groups also reportedly suggest a reintroduction of the criterion requiring the anaerobic biodegradability of surfactants, as well as a ban on all phosphate compounds in both laundry and hand dishwashing detergents.

(Courtesy : inform February 2012, Vol. 23 (2)

KEEP DOCTOR AWAY

Beefing up soybean oil

Could half an ounce of soybean oil a day keep the doctor away? It might, if it is the soybean oil Chelsey Castrodale worked with as a graduate student in the lab of Andrew Proctor, a professor in the Department of Food Science at the University of Arkansas (Fayetteville, USA).

KATHY HEINE

Investigating the oxidative stability of CLA-rich soybean oil required Honored Student Chelsey Castrodale to become well-versed in the analytical techniques used to measure oil quality.

Researchers in Proctor's lab use ultraviolet light to convert the linoleicacid in soybean oil to conjugated linoleicacid (CLA)—a collection of different isomers of linoleicacid that are naturally produced by bacteria in the digestive systems of ruminants (see inform 20:280-281,2009). Medical and nutritional research has shown that these naturally derived isomers may have antioxidant properties, reduce body fat, and offer protection against atherosclerosis, diabetes, and inflammation.

Interestingly, photoisomerization with ultraviolet light results in soybean oil that is 20% CLA (see inform 20:280-281, 2009). Just half an ounce provides 3 grams of CLA that could easily be delivered via salad dressing or, since potato chips contain 39% oil, 1.5 ounces of potato chips. Such products would also offer the benefits of soybean oil.

It is an exciting idea, but some previous studies had shown that CLA isomers are less oxidatively stable than other dienoic fatty acids - something that could shorten their shelf life. Would that be the case with CLA-enriched soybean oil?

In fall 2010, Castrodale embarked on a master's thesis project to investigate the oxidative stability of CLA-rich soybean oil. A key objective was to determine if an iodine catalyst used during the photometric conversion had any effect on its oxidative stability. Doing so required her to become well-versed in analytical techniques used to measure oil quality including gas chromatography (GC), GC-mass spectrometry, and attenuated total reflectance-Fourier transform infrared—skills that will complement those she developed during her undergraduate honors thesis research project at the University of Arkansas in which she studied the processing and storage effects on the polyphenolic content and antioxidant capacity of conventional and sugar-free blue-berry jams.

Castrodale ultimately learned that the iodine catalyst did have a slight negative effect on the oxidative stability of the oil. She presented her results in a poster entitled "Oxidative stability of conjugated lin-oleic acid-rich soy oil" during the 102nd AOCS Annual Meeting & Expo (AM&E) May 1-4, 2011, in Cincinnati, Ohio (USA).

Her work distinguished her as one of nine AOCS students to receive a 2011 Honored Student Award at the AM&E and earned her the Peter and Clare Kalustian Award that recognizes outstanding merit and performance by an AOCS Honored Student. Best of all, it helped her land a job with ADM-Cocoa. Beginning with blueberry jam and moving on to soybean oil, chocolate is the next big step on Castro-dale's tasty career path.

(Courtesy : inform February 2012, Vol. 23 (2))

A REVOLUTION

Supercritical fluid-based extraction/ processing: then and now

Jerry W. King

THE term "supercritical fluid extraction" (SFE) in the field of oils and fats processing often brings to mind a technology that emerged in the early 1980s as a potential replacement for hexane extraction of commodity seed oils [1]. Despite promising laboratory and pilot plant-scale tests, the technology's application to seed oils languished owing to high capitalization costs and the inability to develop a consistent solids feed system comparable to those used in conventional organic solvent-based processes. Industrial adoption waned in ensuing years even though several novel approaches to feeding solids into high-pressure extractors, such as high-pressure lock hoppers or auger-based screw conveyors, were developed [2].

Despite this setback, SFE is alive and well and being applied to many substrates that contain lipid matter. If a "production plant" is defined as a process that produces a product for sale, then it has been estimated that there are over 125 plants worldwide using critical fluids. Most of these facilities use supercritical carbon dioxide (SC-CO,) since CO_2 is environmentally benign and readily available from the atmosphere, geological deposits, and fermentation processes (such as bioethanol production). Indeed, in this author's 40 years of association with this field, the concept of locating an SFE-based processing facility next to a bioethanol production facility has often been mentioned.

Both sub- and supercritical propane have also been used to produce food products, particularly those with a lowered fat content. SC-CO, and propane are GRAS-approved (i.e., are Generally Recognized As Safe by the US Food and Drug Administration) for contact with foodstuffs; and the use of food-compatible co-solvents with SC-CO2, such as ethanol, extends the range of SFE for processing substrates that can contain polar lipids (such as phospholipids) and related compounds [3].

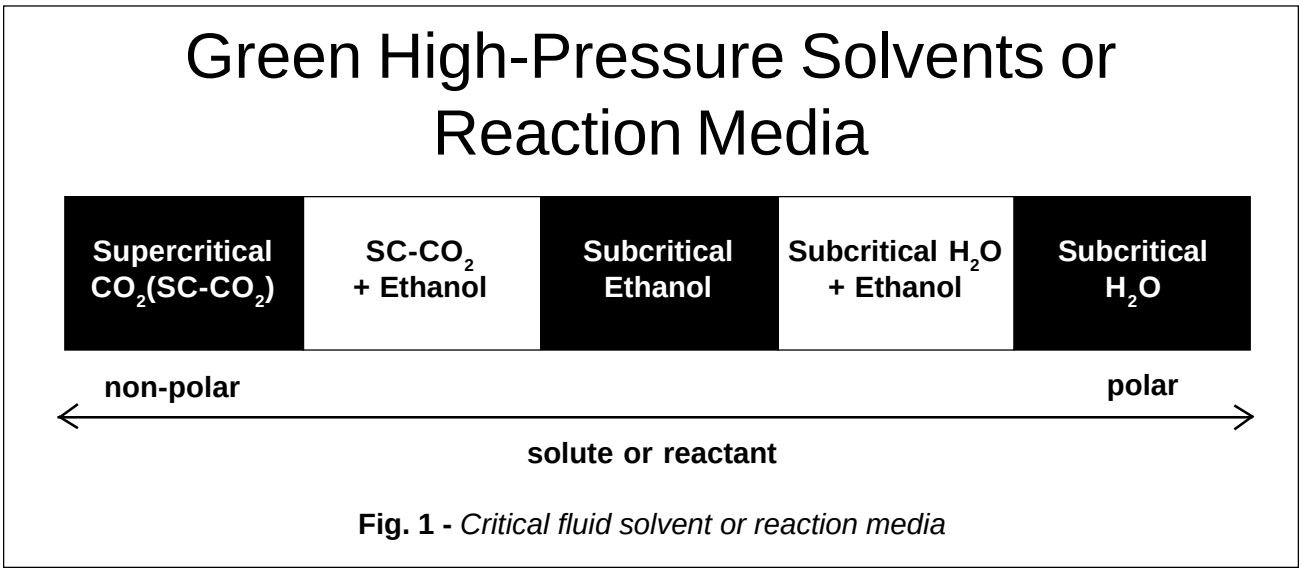


Fig. 1 - *Critical fluid solvent or reaction media*

Figure 1 illustrates the spectrum of critical fluid-based solvents that can be applied to lipophilic substrates to produce food and nutra-ceutical ingredients from lipid-containing feedstocks. In applying SFE to foods and agricultural materials processing, issues such as the degree of comminution and substrate water content have a significant effect on the resultant extract and must be controlled to ensure the desired result. A prime example is the often-cited SFE of water-tempered coffee beans and teas that have been used to produce commercial products for some time now using SC-CO_2 extraction.

Expanding the role of supercritical fluids

It is interesting to examine the developmental eras of critical fluid-based technology (Fig. 2) and their relevance to lipids processing. From the early 1980s, the processing technology expanded into modes/other than just SFE. The rise of supercritical fluid fractionation (SFF) ethodology, embracing columnar-based schemes using distillation-pe towers, as well as production-scale supercritical fluid chromatogphy (SFC), is documented in the literature [4], but these techniques ive faced stiff competition from technologies such as molecular stillation and high-performance liquid chromatography (HPLC). olumnar fractionation-based methods, based on longitudinal tem-;rature gradients along the column, can be operated in either con-irrent or countercurrent modes with respect to substrate feeds vs. >w of the critical fluid. Such an approach can enrich lipid-containing ixtures with respect to their concentration in the natural oil matrix, suiting in extracts or raffinates with potential value as nutraceutical gredients or functional food additives. Toward that end, producan plants have evolved to concentrate lipids such as tocopherols, gments, and sterols.

During the late 1980s and early 1990s, critical fluid-based tech-ques were gradually adopted by analytical chemists. Regulatory pres-res to reduce the use of organic solvents in laboratory environments ade SFE attractive to chemists because SC-CO2 is a virtually solintless extraction medium. Considerable effort was made to develop Iraction and cleanup techniques [5]. With respect to lipid matter id food analysis, three main themes emerged: (i) application for tal fat/oil content as a replacement for Soxhlet-based methods, (ii) [traction of trace analytes followed by fractionation of lipid-contain-g material, and later (iii) assays compatible with the demands of the S Nutritional Labeling and Education Act of 1990. Although many iphisticated methods and types of instrumentation were developed iring this period, competition from reduced solvent-based techniques ssened the use and impact of SFE in analytical chemistry. Neverthe-ss, many SFE techniques became standard operating procedures both the United States and abroad, and these instrumental approaches mtinue to be used in support of process research and development.

Likewise, supercritical fluid chromatography (SFC) has found a irticular niche in the pharmaceutical industry for the rapid character-ation of chiral compounds. From the perspective of current applied 5id analysis, SFC is a very complementary and perhaps preferred chnique to gas chromatography and HPLC for the rapid character-ation of the major groups in biodiesel synthesis, as demonstrated in ie early 1990s [6]. Within 30 minutes or less, SFC can break down e major functional lipid groups such as fatty acids, mono-, di-, and iglycerides found in biodiesel so they can be quantified.

Reactions of interest to the oils-fats-lipids community have been jveloped using sub- and supercritical fluid media. Although there are :ceptions, most reaction scenarios fall into one of three categories:) enzymatic-initiated reactions, (ii) hydrogenation of oils and oleo-lilic derivatives, and (iii) hydrolysis-based transformations produced the presence of subcritical water and SC-CO,—both neat and in the “esence of various catalysts. Initial studies using primarily Upases in ie presence of predominantly SC-CO appeared in the early 1990s ‘]. Enzymatic catalysis in the presence of supercritical fluids may not ; practical for large-scale transformation of the lipids because of the insitivity of enzymes to the presence of water, their denaturation at igh temperatures and pressures, and their cost. However, niche appli-itions in the synthesis of specialty chemicals or aroma compounds, i which avoidance of organic solvents is desired and consumer safety concern, appear more feasible.

Developments in CF Technology

1970 - Supercritical Fluid Extraction (SFE-Foods)
1977 - Energy Applications (Fermentation, Fuels, etc.)
1980 - Analytical Applications (SFE + SFC)
1982 - Supercritical Water Oxidation
1988 - Supercritical Fluid Fractionation (SFF)
1993 - Supercritical Fluid Reactions (SFR- Enzymatic, Hydrogenation)
1993 - Applications in Material Science + Cleaning Technology
1996 - Fine Particle Production
1997 - Renaissance of SFE/SFF (Nutraceuticals, Herbals, etc.)
1997 - Green Chemistry/Engineering (Integrated Processing)
2000 - Sustainability/Bioenergy/Biomass

FIG. 2. *Sequence of developments in critical fluid technology. SFC, supercritical fluid chromatography.*

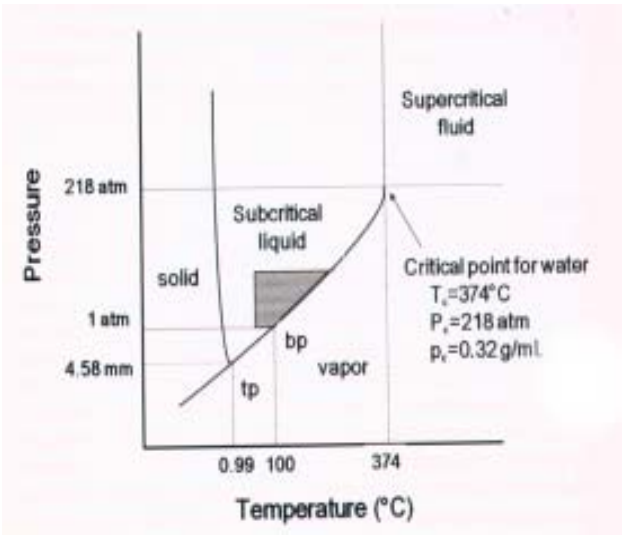


FIG.3. The phase diagram for water as a function of temperature and pressure. Abbreviation : tp, triple point; bp, boiling point

FIG. 4. Osaka, Japan: "Eco-Town" subcritlcal water hydrolysis plant.

Hydrogenation in the presence of supercritical fluids offers some interesting possibilities since the kinetics for such reactions can be accelerated by 500-1000 times and offer benefits in product selectivity and postreaction isolation of products [8]. The synthesis of oleochemi-cal derivatives such as fatty alcohols, using either SC-CO2, propane, or n-butane, can be more environmentally benign, as demonstrated by van den Hark et al. [9] on a pilot plant scale, and by others.

Hydrolysis of fats or oils—traditionally called "fat splitting"— has been accomplished since the 1940s in the presence of subcriti-cal water above its boiling point but under pressure as illustrated in Figure 3. Although traditional fat splitting is often recognized as a hydrolysis process, it actually is using water in its subcritical state, and actually offers a "green," catalyst-free method for the hydrolysis of oils-fats and related materials. By exploiting the temperature dependence of water's hydrolysis constant (Kw), acid-base chemistry becomes possible even at modestly elevated pressures and temperatures, in contrast to the higher pressures required in supercritical fluid-based processes. In terms of biofuels, the treatment of recycled synthetic and bio-derived wastes using subcritical water for hydrolysis has been demonstrated as an appropriate method for the conversion of waste fats into biodiesel, or for the production of methane and methanol fuels from mixed biowaste streams, and it is appropriate for integration in a sequential manner with a liquid or SC-CO2-based unit process [10].

One large-scale example of a subcritical water-based processing plant is shown in Figure 4, located in "Eco-Town" in Osaka, Japan, which is capable of processing industrial and biowaste into useful energy-related products, such as methane, methanol, and fatty acids for conversion to biodiesel.

CO_2 and water for lipids?

The mixing of CO, both at low and high pressures with water as well as the addition of CO2 to organic liquids has fostered some unique chemistry that is green and sustainable and that often results in superior products. The addition of CO, to water, of course, results in its acidification below a pH~3.0, depending on the CO, pressure and temperature of the aqueous solution. As noted previously, these conditions can be exploited for acid

hydrolysis of lipid moieties. Even oil and fat mixtures containing low levels of moisture are not immune to an autocatalytic effect in the presence of COr The glycerolysis or methanolysis of oil-/fat-containing materials can be accomplished in the mere presence of CO, without resorting to the addition of a catalyst to initiate the reactions. Such an approach is very attractive from a green synthesis perspective. The addition of pressurized CO2 to some conventional organic liquids results in a gas-expanded fluid that exhibits properties intermediate between those of a gas and liquid. Wyatt and Haas [11] as well as others have demonstrated the applicability of this approach for the methanolysis of oils-fats to methyl esters.

SFE redux and a plethora of products

There has been considerable progress in developing CO,-assisted expellers that permit continuous SFE. Though this concept dates back to the mid-1980s when an auger-type screw press was used to assist in the SFE of oils from seeds [2], it has only recently been realized on a plant production scale. In this hybrid system, the SC-CO2 contacts the oil seed matrix in the expeller barrel. The supercritical fluid phase is created by the hydraulic compression of the feed matrix-fluid mixture, which results in an increase in the temperature and pressure in the expeller barrel. This compression process also enhances the fluidity of liquids, thereby enhancing the extraction of oil as the seeds are expelled. This concept is being tested for the extraction of oil from seeds by several US companies on a pilot scale. This commercial system, as offered by Crown Iron Works, is known as the HIPLEX process and is due largely due to the efforts of Foidl [12]. High oil yields have been obtained from soybean and canola oilseed. These have produced functional meals for incorporation into foods; further de-oiling of press cakes is also possible using this approach. More details on CO,-assisted expelling can be found in the chapter by Srinivas and King in Functional Food Product Development [13].

SFE continues to find applications too numerous to mention in this update. As judged from the variety of lipophilic extracts available as commercial products, including those that explicitly state they are “supercritical” in origin, the future continues to look bright for SFE in the high-value lipophilic extractives marketplace. Specialty products such as polyunsaturated fatty acid esters derived from fish oils, neat and roasted sesame oil, cranberry seed-based oils, oils high in n-3- and n-6 fatty acid content, pumpkin seed and sea-buckthorn seed-derived extracts, mustard seed oil, SC-CO,-derived chia seed oil, and fiber for nutraceutical use join the traditional SFE-derived products, including decaffeinated coffee, hops extract, ginseng, and spice and antioxidant extracts. The lipophilic extract, using predominantly SC-CO,, from sawtooth palmetto berry is a proven treatment for prostate problems. Often these extracts are advertised as “hexane-free,” as are the expeller-based products. Newer niche products have emerged in the past two years such as ayurvedic medicine extractives that are produced by extraction with SC-CO, followed by a hydro-ethanolic pressurized solvent extraction.

An array of critical fluid-based processing operations can be applied to a common agricultural commodity such as rice or rice bran. Hence, SFE can be applied to derive the oil, which can then be fractionated using SC-CO2 or hydrolyzed into its constituent fatty acids by using subcritical water. Several plant-scale facilities now exist in Asia for treating rice to retard the development of rancidity and extend the rice product’s shelf life, as described by Kinget al. [14].

In the late 1980s, the cosmetic industry paid little attention to lipophilic extractives derived by SC-CO, extraction. This has changed somewhat with the incorporation of SC-CO,-derived jojoba extracts, lutein esters for topical applications, and SFE-derived Job’s tears extracts for the Asian cosmetics marketplace. There is even an SC-CO,-derived “organic sexual lubricant” called “Nude.”

These new marketplace developments are important since current schemes for processing algae-derived oils for biodiesel use advocate the removal of higher-value lipophilic components such as antioxidants and pigments prior to conversion to methyl esters for use as biodiesel.

The most recent knowledge in this field will be presented at the 10th International Symposium on Supercritical Fluids (ISSF), to be held May 13-16, 2012, in San Francisco, California, USA. This series of ISSF symposia highlights the latest developments in the field with topical sessions on bio-

mass and energy-related conversions, reactions in critical fluids, natural products/nutraceuticals/ food-related materials, industrial applications of critical fluids, green chemistry/engineering, supercritical fluids, and more.

(Courtesy : inform February 2012, Vol. 23 (2))

SPRING BOARD

Jatropha on trial in eastern Asia

JOIL PTE. LTD., a bioenergy crop developer headquartered in Singapore, announced results in March from first-year field trials of its jatropha varietals S1 and S2 in its fields in India. Calculations showed a yield exceeding 2 metric tons per hectare (MT/ha). The company indicated that these results, from marginal land plots in the Indian state of Tamil Nadu, are a significant advancement compared with wild-type jatropha plants that typically do not flower within the first year.

Hong Yan, chief scientific officer for JOil, said, "Given that jatropha matures and reaches peak yield in three to four years, this shows that the JOil open-pollinated varieties have the potential to reach mature yields of more than 5 MT of seeds per hectare, at which point the production of jatropha seed reaches a level that allows it to be a sustain-able feedstock for large-scale commercial production of biodiesel for airlines and motor transport fleet operations" (tinyurl.com/ jatropha-trials-India).

JOil is presently conducting tests in two states of India and in West Java. JOil's partner Toyota Tsusho is carrying out trials of jatropha in the Philippines and Cambodia. Sriniva-san Ramachandran, chief technology officer of JOil, said, "We are embarking on an expanded field trial program that will see our elite jatropha grown in Kenya, Tanzania, Egypt, China, Malaysia, and Vietnam." The purpose of these multi-location trials is to help JOil evaluate the performance of its elite varieties and help identify which ones work best in different agro-climatic environments, Ramachandran said.

(Courtesy : inform February 2012, Vol. 23 (2))

MEMORY TRAP

Plants "remember" drought, adapt

RESEARCH carried out at the University of Nebraska-Lincoln (UNL; USA) shows that plants subjected to a previous period of drought learn to deal with the stress owing to their "memories" of the experience. The research also confirms for the first time the scientific basis for what home gardeners and nursery professionals have often observed: Transplants do better when water is withheld for a few days to drought-harden them before the move. According to Michael Fromm, a plant scientist with UNL and one of the coauthors of the research, "This phenomenon of drought hardening is in the common literature but not really in the academic literature. The mechanisms involved in this process seem to be what we found" (news-room.unl.edu/ blog/ ?p= 1034).

Working with Arabidopsis, a member of the mustard family, Fromm, plant molecular biologist Zoya Avramova, and post-doctoral fellow Yong Ding compared the reaction of plants that had been previously stressed by withholding water to those not previously stressed (see "Multiple exposures to drought 'train' transcriptional responses in Arabidopsis," Nature Communications, doi:10.1038/ ncomms!732, 2012).

The prestressed plants bounced back more quickly the next time they were dehydrated. That is, the nontrained plants wilted faster than trained plants, and their leaves lost water at a faster rate than trained plants. Fromm said, "The plants 'remember' dehydration stress. It will condition them to survive future drought stress and transplanting."

The team found that the trained plants responded to subsequent dehydration by increasing transcription of a certain subset of genes. During recovery periods when water is available, transcription of these genes returns to normal levels, but following subsequent drought periods the plants remember their transcriptional stress response and induce these genes to higher levels in this subsequent drought stress."

Arabidopsis forgets this previous stress after five days of watering, although other plants may differ in that memory time. This is the first instance of

transcriptional memory found in any life form above yeasts.

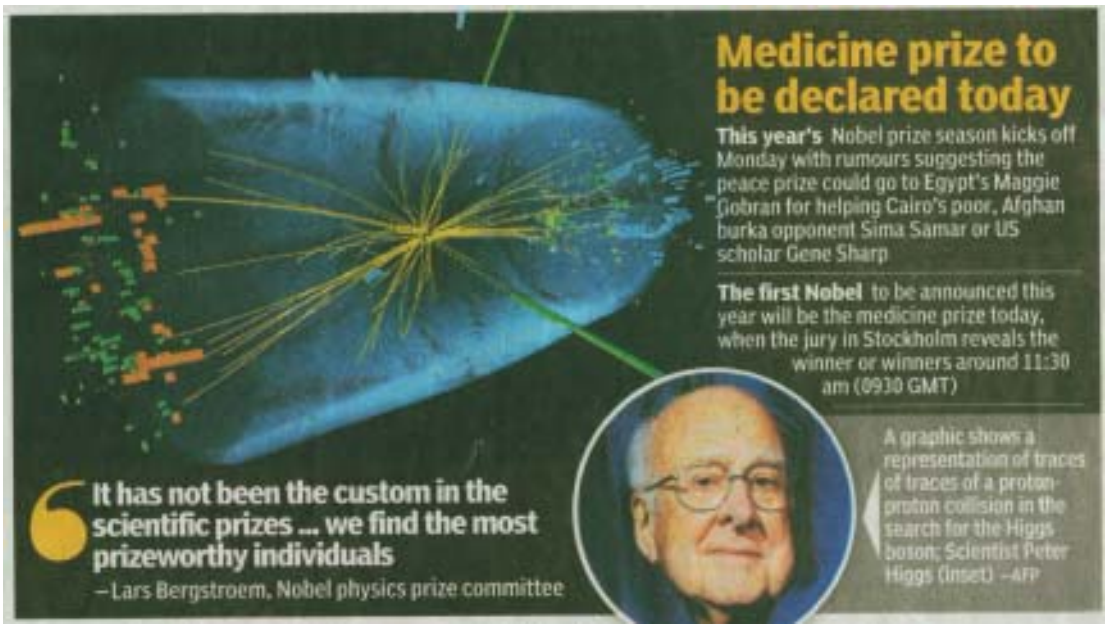
This discovery may lead to breeding or engineering of crops that would better withstand drought, although practical applications of these findings in agriculture are years away, Fromm said.

Home gardens,though ,can make immediate use of these findings."If I was transplanting something,I would despire it of water for a couple of days,then water overnight,then transplant," From said.

(Courtesy : inform February 2012, Vol. 23 (2))

NOBEL LAUREATTES

A dilemma of Nobel proportions



Will the Higgs boson-particle discovery be awarded the Physics Prize in Stockholm?

Paris:

On July 4, scientists announced they had discovered a new particle that may be the fabled Higgs boson, an exploit that would rank as the greatest achievement in physics in more than half a century. But they also created a headache for the jury that will decide next Tuesday's Nobel Prize for Physics.

Historic though it is, does the announcement deserve the award? And if so, who should get it? The breakthrough at the European Organisation for Nuclear Research (CERN) touches on the agonising quest to find the "God particle," so called for being everywhere and elusive at the same time. Named after British physicist Peter Higgs, the boson is a key to our concept of matter, as it could explain why particles have mass.

Without the Higgs, the Universe as we know it would simply not exist, according to the theory. "This is the physics version of the discovery of DNA," says Peter Knight, president of Britain's Institute of Physics. But whether the July 4 fireworks will unlock the great prize is unclear. "It's a big discovery. That's all I'm going to say," Lars Brink, a

member of the Nobel committee for physics said.

Some Nobel-watchers are cautious, given that the new particle has not yet been officially sealed as the Higgs. Scientists are almost certain it is the coveted beast, for they found it at a range of mass that fits with their calculations. Yet they still need to confirm this, which means further work to see how it behaves and reacts with other particles.

Indeed, there is a remote possibility that the new particle is not the Higgs, although this would be an even more ground shaking announcement. As Higgs himself readily admits, vital contributions to the theoretical groundwork were made by others. In fact, six physicists, each building on the work of others, published a flurry of papers on aspects of the theory within four months of each other back in 1964. The first were Belgians Robert Brout, who died last year, and Francois Englert.

A graphic representation of traces of a proton-proton collision in the search for the Higgs . I boson; Scientist Peter Higgs (inset) -AFP

This was followed by Higgs, who was the first to say only a new particle would explain the anomalies of mass. Then came a trio of Americans Dick Hagen and Gerry Guralnik and Briton Tom Kibble. A further complication is that thousands of physicists

worked in the two labs at CERN's Large Hadron Collider near Geneva where Higgs experiments were conducted independently of each other. So the question is whether the jury considers July's announcement to be sufficient even

if the boson's Higgsishness remains unconfirmed. Then it must decide whether theoreticians or experimentalists - or both - should get the glory: At most three names, although they can include organisations, can share a Nobel, but the prize

cannot be given posthumously.

The Nobel will "eventually" go to the Higgs, "but not this year, as the evidence has come rather late, and it is not yet certain that the newly-discovered particle is in fact a Higgs boson," predicted John Ellis, professor of theoretical physics at King's College London and a researcher at CERN. Etienne Klein, a physicist at France's Atomic Energy Commission (CEA), said the boson was a shoo-in for a Nobel. He urged the jury to "take a gamble" and award it jointly to Higgs, Englert and CERN. "You must also note that Higgs is not in the bloom of youth" - he is 83 - "and this may be a form of age-related pressure which would help," said Klein. Pierre Marage, vice rector of academic policies and research at the Free University of Brussels. "There's nothing stopping us from giving the prize to an organisation. But it has not been the custom in the scientific prizes," said Lars Bergstroem, secretary of the committee for the Nobel physics prize. "The Nobel Peace Prize has often been awarded to organisations. But in the science prizes we have tried to find the most prizewor-thy individuals." -AFP

(Courtesy : DNA)

NOBEL LAUREATTES

Medicine Nobel for stem cell discovery

UK, Japan scientists with research 40-years apart win the prize for findings that could help repair tissues

Stockholm: Scientists from Britain and Japan shared a Nobel Prize on Monday for the discovery that adult cells can be transformed back into embryo-like stem cells that may one day re-grow tissue in damaged brains, hearts or other organs.

John Gurdon, 79, of the Gur-don Institute in Cambridge, Britain and ***Shinya Yamanaka, 50***, of Kyoto University in Japan, share the $1.2 million

Nobel Prize for Medicine, for work Gurdon began 50 years ago and Yamanaka capped with a 2006 experiment that transformed the field of "regenerative medicine" - the search for ways to cure disease by growing healthy tissue.

"These groundbreaking discoveries have completely changed our view of the development and specialisation of cells," the Nobel Assembly at Stockholm's Karolinska Institute said.

All of the body starts as stem cells, before developing into tissue like skin, blood, nerves, muscle and bone. The big hope is that stem cells can grow to replace damaged tissue in cases from spinal cord injuries to Parkinson's disease. Scientists once thought it was impossible to turn adult tissue back into stem cells. That meant new stem cells could only be created by taking them from embryos, which raised ethical objections that led to research bans in some countries.

In a news conference in Japan, Yamanaka thanked his team of young researchers: "My joy is very great. But I feel a grave sense of responsibility as well." Gurdon spoke of his own unlikely career as a young man who loved science but was steered away from it at school, only to take it up again at university. He still keeps an old school report in a frame on his desk: "I believe he has ideas about becoming a scientist... This is quite ridiculous," his teacher wrote. "It would be a sheer waste of time, both on his part and of those who have to teach him."

The techniques are being used to grow cells in laboratories to study disease, the chairman of the awards committee, Urban Lendahl said. "You can't take out a large part of the heart or the brain or so to study this, but now you can take a cell from, for example, the skin of the patient, reprogramme it, return it to a pluripotent state, and then grow it in a laboratory," he said. "The second thing is for further ahead. If you can grow different cell types from a cell from a human, you might - in theory for now but in future hopefully - be able to return cells where cells have been lost."

John Gurdon (R) and Shinya Yamanaka

Thomas Perlmann, Nobel Committee member and professor of Molecular Development Biology at the Karolinska Institute said: "Thanks to these two scientists, we know now that development is not strictly a oneway street.There is lot of promise and excitement, and difficult disorders such as neurodegenera-tive disorders, like perhaps Alzheimer's and, more likely, Parkin-son's disease, are very interesting targets."

-Reuters

Thanks to these two scientists... difficult disorders such as neurodegenerative disorders, like perhaps... Parkinson's disease, are very interesting targets.

-Thomas Perlmann, Nobel Committee member Controversy and hurdles

Contraversy and Hurdles

Research in preprogrammed cells, which on Monday earned the 2012 Nobel Prize, has been hailed as a new dawn for regenerative medicine but remains troubled by several clouds.

Stem cells are touted as a source of replacement tissue, fixing almost anything from malfunctioning hearts and lungs, damaged spines, Parkinson's disease or even baldness.

The first human trials were launched only in 2010, and progress has been dogged by the contested use of stem cells taken from early-stage

embryos, where the most adaptable, or pluripotent, cells are found .

George W Bush

"retarded the field for years" by blocking US government funds for human embryonic stem cell research, a decision reversed in 2009 by President Barack Obama, Shinya Yamanaka said.

(Courtesy : DNA)

If you can grow different cell types from a cell from a human, you might ... be able to return cells where cells have been lost.

- Urban Lendahl, chairman of the awards committee

NOBEL LAUREATTES

Economical Nobel for matchmakers

Alvin E Roth, Lloyd S Shapley bag prize for efficient markets theory.

Niklas Magnusson & Josiane Kremer
HAMBURG

Alvin E Roth (pictured left) and Lloyd S Shapley shared the 2012 Nobel Prize in Economic Sciences for their exploration of how to make markets work more efficiently by better matching supply with demand.

"The combination of Shapley's basic theory and Roth's empirical investigations, experiments and practical design has generated a flourishing field of research and improved the performance of many markets," the Royal Swedish Academy of Sciences, which selects the winner, said in a statement in Stockholm on Monday. "This year's prize is awarded for an outstanding example of economic engineering."

Shapley, 89, used cooperative game theory to study and compare different matching methods, designing the so-called Gale-Shapley algorithm. His theories were built on by Roth, 60, who used experimental economics and market design to solve real-world problems, including matching 20,000 doctors annually with US hospitals during their first year of employment and 90,000 teens with New York City high schools.

Roth, who has been a professor of economics and business administration at Harvard in Cambridge, Massachusetts, since 1998, is leaving the school at the end of the year for a new position at Stanford University, where he is currently a visiting professor of economics. Shapley is currently Professor Emeritus at the University of California, Los Angeles.

"1 was sleeping when I got the call,"

Roth said by phone to reporters gathered in Stockholm. "My students will pay more attention now. It was expected that Shapley would win; it would have been a great oversight if he hadn't. 1 am very honoured to share it with him."

Laureates have seen their economic theories win broader recognition outside academic circles and brought closer to policy making. Past winners include Milton Friedman, Amartya Sen, James Tobin, Paul Krugman, Robert Solow and Friedrich August von Hayek.

The award provides "a platform from where you can talk about your ideas," Christopher Pissarides, who shared the 2010 prize with Peter Diamond and Dale Mortensen for research into the difficulties of matching supply and demand, said in an October 12 interview. "People will listen and do something about it."

Last year's prize was awarded to US economists Thomas J Sargent and Christopher A Sims for their work in exploring cause and effect in policy. In 2009, Elinor Ostrom became the first woman to win when she received the prize together with Oliver Williamson for investigating the limits of markets and how organisations work.

Annual prizes for achievements in physics, chemistry, medicine, peace and literature were established in the will of Alfred Nobel, the Swedish inventor of dynamite who died in 1896, and the first prizes were handed out in 1901. The economics award was set up by Sweden's central bank in 1968. The official name is The Sver-iges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel. The money, 8 million kronor ($1.2 million) will be handed out to the laureates at a ceremony in Stockholm on December 10, the anniversary of Nobel's death.

(Courtesy : DNA)

NOBEL LAUREATTES

Cell receptor study wins Nobel for US duo

Stockholm: Two American researchers won the Nobel Prize in chemistry on Wednesday for studies of protein receptors that let body cells sense and respond to outside signals like danger or the flavour of food. Such studies are key for developing better drugs.

The Royal Swedish Academy of Sciences said Robert Lefkowitz and Brian Kobilka had made groundbreaking discoveries, mainly in the 1980s, on an important family of receptors, known as G-protein-coupled receptors.

About half of all medications act on these receptors, including beta blockers and antihistamines, so learning about them will help scientists to come up with better drugs.

The human body has about 1,000 kinds of such receptors, structures on the surface of cells, which let the body respond to a wide variety of chemical signals, like adrenaline. Some receptors are in the nose, tongue and eyes, and let us sense smells, tastes and light.

"They work as a gateway to the cell," Lefkowitz told a news conference in Stockholm by phone.

US scientists Robert Lefkowitz (left) and Brian Kobilka have won the Chemistry Nobel

"As a result they are crucial... to regulate almost every known physiological process mans."

Lefkowitz, 69, is an investigator at the Howard Hughes Medical Institute and professor at Duke University Medical Center in Durham, North Carolina. Kobilka, 57, worked for Lefkowitz at Duke before transferring to Stanford University School of Medicine in California, where he is now a professor.

Lefkowitz said he was fast asleep when the Nobel committee called, but he didn't hear it because he was wearing ear plugs. So his wife picked

up the phone. “She said, There’s a call here for you from Stockholm,’” Lefkowitz said.

“1 knew they ain’t calling to find out what the weather is like in Durham today.” He said he didn’t have an “inkling” that he was being considered for the Nobel Prize.

“Initially, I expected I’d have this huge burst of excitement. But 1 didn’t. I was comfortably numb,” Lefkowitz said. Kobilka said he found out around 2:30 a.m., after the Nobel committee called his home twice. -AP

(Courtesy : DNA)

NOBEL LAUREATTES

Duo get Nobel in physics for quantum ‘parlour trick’

French, American scientist to share Nobel Prize in Physics for finding ways to measure quantum particles

Stockholm:

A French and an American scientist won the Nobel Prize on Tuesday for finding ways to measure quantum particles without destroying them, which could make it possible to build a new kind of computer far more powerful than any seen before.

Serge Haroche of France and American David Wineland, both 68, found ways to manipulate the very smallest particles of matter and light to observe strange behaviour that previously could only be imagined in equations and thought experiments.

Wineland has described his own work as a “parlour trick” that performed the seemingly magical feat of putting an object in two places at once. Other scientists praised the achievements as bringing to life the wildest dreams of science fiction.

“The Nobel laureates have opened the door to a new era of experimentation with quantum physics by demonstrating the direct observation of individual quantum particles without destroying them,” said the Royal Swedish Academy of Sciences, which awarded them the 8 million crown Nobel Prize in Physics.

French physician Serge Haroche (right) and American David Wineland (inset) get the 2012 Nobel Prize in physics

“Perhaps the quantum computer will change our everyday lives in this century in the same radical way as the classical computer did in the last century.” Haroche said he was walking in the street with his wife when he recognised the Swedish country code on the incoming call to inform him of the award.

“I saw the area code 46, then I sat down,” he told reporters in Sweden by telephone. “First I called my children, then I called my closest colleagues, without whom I would never have won this prize,” he said.

Asked how he would celebrate, he said: “I will have champagne, of course.”

He said he hoped the prize would give him a

platform "that will allow me to communicate ideas, not just in this field of research but for research in general, fundamental research".

Physics is the second of this year's crop of awards; scientists from Britain and Japan shared the first prize on Monday, in medicine, for adult stem cell research. The prizes, which reward achievements in science, literature and peace, were first awarded in 1901 in accordance with the will of Swedish dynamite millionaire Alfred Nobel. -

Athens:

German Chancellor Angela Merkel told Greece on Tuesday that the "tough path" of painful spending cuts will pay off, as tens of thousands of protesters massed in the capital in a show of anger against her visit to the eurozone's most indebted nation. Police fired tear gas to disperse protesters attempting to storm a barricade just blocks away from where Merkel was meeting with Greek prime minister Antonio Samaras,

French physician Serge Haroche (right) and American David Wineland (inset) get the 2012 Nobel Prize in physics -Agencies while small gangs of masked youths threw bottles at riot police.

While the German leader hailed the progress of reforms undertaken by Athens, 30,000 protesters brandishing banners reading "You are not welcome, Imperialisten Raus" (Imperialists out) or "No to the Fourth Reich" vented their anger against the budgetary disdpline preached by her.

Two Nazi flags were draped on a steel barricade near parliament and set on fire. Vilified for the punishing spending cuts imposed in recession-hit Greece, Merkel, the leader of Europe's paymaster, is on her first visit to the country since the eurozone debt crisis erupted three years ago.

Merkel has become a hate figure in Greece over the tough spending cuts imposed on the country in return for promised loans and debt relief worth about 347 billion euros ($448 billion).

(Courtesy : DNA)

Honours in Physics

The 2012 award was won for groundbreaking experimental methods that "enable measuring and manipulation of individual quantum systems".

105 Nobel Prizes in Physics have been awarded to 191 Laureates between
1901-2011. John Bardeen has been won the prize twice.

Only two women have won the prize, Marie Curie in 1903 and Maria Goeppert-Mayer in 1963. Curie won in 1903 with her husband Pierre.

WINNERS INCLUDE:

Wilhelm Conrad Roentgen won the first Nobel Prize in 1901 for his discovery of X-Rays;

Guglielmo Marconi in 1909 for his contribution to radio communications;

Max Planck in 1918 for quantum theory;

Albert Einstein for his theory of relativity in 1921 and

Enrico Fermi in 1938 for his work on induced radioactivity.