Biotechnology Journal
www.biotechnology-journal.com
Biotechnol. J. 2014, 9, 1473–1475
DOI 10.1002/biot.201400485

Meeting report: The 1st BRG-training school in Asia, a first step in the building of an ASEAN encapsulation network

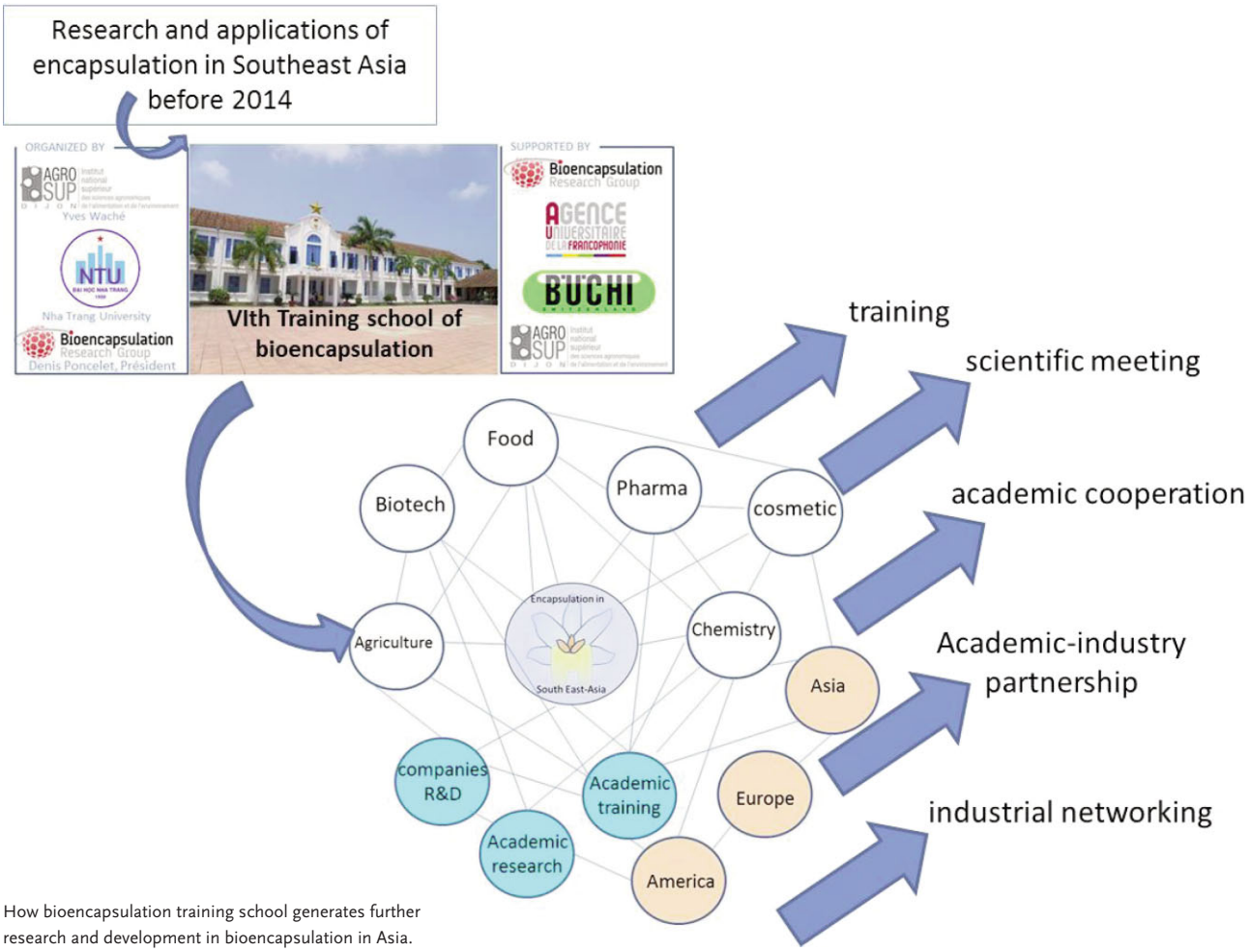
The 6th training school on bioencapsulation of the Bioencapsulation Research Group (BRG http://bioencapsulation.net/2014_Nha_Trang/index1.html) took place in Nha Trang, Vietnam, in March 2014. This event, organised by Agro-Sup Dijon, Nha Trang University and the BRG with the support of the Agency of French-Speaking Universities (Agence Universitaire de la Francophonie, AUF) and Büchi was the first BRG-event organised in Asia. The success of this school, which brought together bioencapsulation researchers from eight countries of the Association of Southeast Asian Nations (ASEAN) along with those from Europe, Japan, Australia and many other countries, shows that bioencapsulation is a growing field in Southeast Asia. After a brief presentation of bibliometric data showing the dynamism and the specificities of encapsulation research in Southeast Asia, a presentation of the achievements and needs in some countries is given showing the interest in building a network in this region.

According to data from the Web of Knowledge, the research output in encapsulation has been dominated by researchers in North America and Europe. Although in Western countries many papers on encapsulation have been published since 1995, in ASEAN countries, the growth of publication was very slow until 2005 but is now increasing rapidly and ASEAN countries together have a research output that is comparable in quantity to that of Japan and Korea in encapsulation.

Among ASEAN countries, Singapore, which is one of the countries investing the highest proportion of its GDP on research, has a leading place with a high growth beginning in 2001. Thailand followed with a growth beginning in 2004; however, Malaysia which encountered a 6-fold growth between 2008–2010 and 2011–2013 has now replaced Thailand in the second place. Vietnam, Indonesia and The Philippines are the three other countries publishing papers on encapsulation although their research output remains low. Encapsulation in Southeast Asia also exhibit specificities concerning materials, i.e. less proteins and lipids and more carbohydrates than in western countries, and techniques, e.g. more spray-drying. It has first to be stressed that although there is a huge diversity in the development of ASEAN countries, a programme of integration will start in 2015 that will likely benefit the development of the less developed countries. Among the domains of integration, education will be supported as well as areas of potential economic development. Amongst these areas with potential economic growth are several potential users of encapsulation technology (e.g. agriculture, food industry etc.).

Singapore: the microencapsulation research in Singapore is limited to mostly the academic arena, i.e. within universities and research institutes. Much encapsulation research work is related to the entrapment of bioactives and cells although some are related to engineering materials, as a protective coating. In the manufacturing sector, there are quite a number of companies with encapsulated products. They are generally related to the flavouring, biotechnology, cosmetics, health supplements, biofuel and milk powder companies among others. Many flavour and fragrance companies such as *Givaudan*, *Symrise*, *International Flavors and Fragrances*, and *Firmenich* are located in Singapore and are active in encapsulation research, for regional flavours and some production activities. Singapore is also very active in milk powder products, especially infant and baby milk products with many large manufacturing plants where some specific encapsulations, via spray drying, in milk product production are carried out. A research company, *Austrianova* is described as a high tech, life science and biotech company with a global footprint that encapsulates living cells in bio-inert polymers. Other companies such as *Kemin Industries* are also involved in encapsulated product research as well as excipient companies such as *Ingredion Singapore* have R&D facilities located in Singapore.

Thailand: the Micro-/nano-encapsulation research in Thailand is in an infantile stage as is with other Southeast Asian countries. Thailand is rich in phytonutrients, marine-based bioactive compounds and herbs. Many active researchers from various academic and research institutions are actively involved and thus have been able to publish peer-reviewed articles and a few patents. Most of the articles published are basically on encapsulation of flavour compounds, pharmaceutically active ingredients, phytonutrients and herbs for controlled release and targeted delivery. Most of the researchers use biopolymers as wall-materials. Some of the high-quality researches have yielded patents, such as that of probiotics encapsulation in collaboration with an overseas institution and Pepsi Co. Inc. Ltd. A company, Nuvilex *Partner Austrianova* established its regional headquarters and research and development facility in Thailand for Cell-in-a-Box™ live-cell encapsulation. Development by *Austrianova* of a presence in Thailand and development facility in Southeast Asia is a further step in preparing for the encapsulation of the cancer drug-activating cells that are part of Nuvilex's treat-



How bioencapsulation training school generates further research and development in bioencapsulation in Asia.

ment for advanced pancreatic cancer. Thailand was chosen as the location for the facility because of Thailand's commitment to making a life sciences hub for all of Southeast Asia, economic incentives by the Thai government and the well-educated workforce that resides in Thailand. The largest regional market for food encapsulation technology is North America as a result of food processing manufacturers implementing a high level of technology within their food and beverage industries. However, the strongest growth in investment within the food industry for food encapsulation is forecast to be in Asia including Thailand.

Malaysia is a tropical Southeast Asian country that produces a large variety of phytonutrients for applications in cosmeceuticals, nutraceuticals, food and beverages. Examples of the popular phytonutrients extracted from the indigenous plants are "Tongkat Ali" (*Eurycoma longifolia*), "Misai Kucing" (*Orthosiphon stamineus*), "Hempedu Bumi" (*Andrographis paniculata*), and "Kacip Fatimah" (*Labisia pumila*); while the vitamin-rich tocotrienol and carotenes are extracted from the cultivated oil palm. These phytonutrients are commonly produced in a microencapsulated powder form by spray-drying or freeze-drying for the ease of handling, storage or formulation with other dry components. These microencapsulation processes are easy to perform, even at industrial scale, because they involve simple blending of phytonutrients extracts with carrier materials before drying. However, their shortcomings include limited choice of wall materials, the use of large amounts of wall materials and the poor control over the size and morphology of the particulates formed. These drawbacks may hinder the development of products with innovative characteristics such as improved stability and bioavailability, controlled-release, taste or smell masking, high concentration of bioactives, enhanced dispersion and visual properties. Therefore, more research should be directed towards improving the product characteristics, possibly by applying other micro- or nano-encapsulation methods such as ionotropic gelation, yeast cell encapsulation, film coating and complex coacervation. These methods have been employed for encapsulating many food and drug compounds and thus, they represent a mature technological platform that can be applied to

create value-added phytonutrients for new applications.

Vietnam: since the opening of the economy of Vietnam to the World with the đổi mới beginning in 1986, Vietnam has undergone tremendous economic growth. The income generated by this growth is presently invested in programmes to strengthen the economic development. Several of the selected fields of developments have potential for application of encapsulation technology. Among them, the government supports the development of active plant extracts, probiotics, food safety. In the case of plant extracts and phytonutrients, Indian and Chinese companies already occupy most of the regional market. In this context, the governmental strategy of technological catching up through buying already existing technologies has limited effects. To improve the efficiency of this programme, there would be a need for innovation to propose competitive technological products. Innovation is sometimes defined as the product of creativity by risk. Promoting creativity in encapsulation goes through the training of Vietnamese students and researchers. It has been a long-term objective of *AgroSup* Dijon, which has already trained many Asian students, which was also the very goal of our training school. Several academic programmes propose to elaborate encapsulation processes for probiotic strains or for the oil of the popular local superfruit gấc (*Momordica cochinchinenis*) but to our knowledge, none of these results have yet been transferred to industrial processes at the microcapsule level. However, as an exception confirming the rule, the company Salanganes Nests has developed with Nha Trang University an encapsulated aroma for their famous bird nest product. Moreover, some companies are now offering their services of encapsulation such as *Natencaps*. which proposes tailored-made extraction and encapsulation systems for the controlled use of bioactive compounds in the food and cosmetics fields in Vietnam and Southeast Asian countries.

Cambodia: with its tragic recent history, Cambodia has been deprived of technological developments for many years. It faces now a period of economic growth which has enabled Cambodia to no longer be amongst the poorest countries in the world. It is however in the very early stage of development of an agro-industry and academic research is only beginning. Among the universities concerned, the Institute of Technology of Cambodia (ITC), the first university of technology in the country has integrated, with the support of *AgroSup* Dijon, the techniques of encapsulation in the program of students learning chemistry and food technology. However, the step ahead to transfer this teaching programme into local industrial application is huge although *Natencaps* already participates in a research programme with ITC.

The presentation of encapsulation in Asean-countries is not exhaustive but, except some local specificity, it is likely that most of the countries face a situation comparable to one of the examples presented above. Responses to the problems encountered are to be made at different levels from governmental policies to academic and industrial research. This first training school organised in Nha Trang was successful to make contact for networking and several events are now planned in the future to strengthen collaboration and discussion in these subjects such as the International Symposium on Natural Products in mid-November 2014 in Dalat (Vietnam), an international conference of consensus on active molecules to be held in Dijon (France) in 2015 with a session in Vietnam.

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