



ACADEMICIAN EVELYN MAE TECSON- MENDOZA

Transcending Biochemistry beyond Borders

By Roberta N. Garcia

Dr. Evelyn Mae Tecson-Mendoza is one of the leading biochemists in the Philippines. In 1976, she was invited to head the Biochemistry Laboratory of the Institute of Plant Breeding, College of Agriculture, University of the Philippines Los Baños, by its founding director, Dr. Emil Q. Javier. Since then, Dr. Tecson-Mendoza has remained at the forefront in advancing the fields of plant biochemistry and modern biotechnology in the Philippines. She pioneered and contributed significantly to the discovery of new scientific knowledge, and the development of technologies and

methodologies in the following areas: physicochemical and biochemical studies of important Philippine agricultural crops; biochemical mechanisms of plant resistance against selected pests and diseases; basic studies on coconut oil and proteins including the biochemical basis for the makapuno coconut phenotype; development and use of biochemical and molecular tools in studying genetic diversity of plants and pests; physicochemical, functional, molecular studies and engineering of mungbean proteins; and development of papaya with delayed ripening trait by genetic engineering.

The Early Years

Dr. Evelyn Mae Tecson Mendoza's early fascination with chemistry was inspired by her high school science teacher, Ms. Myrna Ambrosio, a chemist. "She was a very good and inspiring science teacher, very knowledgeable and always smiling," is the way Mae, as Dr. Tecson-Mendoza is called by friends and colleagues, describes her teacher. Surrounded by engineer brothers and a chemist sister, she could not think of any other more logical course for her to take other than chemistry.

While pursuing a BS degree in Chemistry at the Mapua Institute of Technology, her organic chemistry professor, Prof. Lauro Limuaco further kindled her interest in the field. Prof. Limuaco played a pivotal role in Dr. Tecson-Mendoza's career in

ABOUT THE AUTHOR

Dr. Roberta N. Garcia is an associate professor in the Crop Science Cluster-Institute of Plant Breeding (CSC, IPB), College of Agriculture, University of the Philippines Los Baños. She holds a PhD in Biochemistry from UPLB and her researches include coconut and mungbean proteins, and genetic diversity analysis and DNA fingerprinting of crops using isozymes and DNA markers. She has known Dr. Evelyn Mae Tecson-Mendoza since 1990, when she conducted her MS thesis on the enzymes involved in biological nitrogen fixation in mungbean under Dr. Tecson-Mendoza's her supervision. Since then, RNG has continued to work with Dr. Tecson-Mendoza at the IPB Biochemistry Laboratory on various projects on research, education, and extension.

biochemistry research. When National Scientist Bienvenido O. Juliano, then a young senior scientist at the International Rice Research Institute (IRRI), came to Mapua to recruit junior researchers, Prof. Limuaco recommended her to be interviewed. Graduating *cum laude* (gold medalist), she was then chosen and became one of Dr. Juliano's research assistants at IRRI's Cereal Chemistry Laboratory.

At IRRI, everything was Greek to her at the start. But Mae learned the ropes quickly, especially with mentoring by Dr. Juliano and a junior researcher, Ms. Evelyn Palmiano, and learned to work hard, to work independently, as well as with a team. Her saga in biochemical research began with the study of the isolation, purification, and characterization of the major protein of rice called glutelin. Her two years of research under Dr. Juliano resulted in a scientific article on rice glutelin in 1971[1], a pioneering work that up to now is cited by researchers working on rice proteins.

Her stay at IRRI was cut short when she was awarded a Fulbright-Hays Grant in 1969 to pursue graduate studies in Biochemistry at the University of Massachusetts Amherst, USA. She first started as an organic chemistry major but transferred at once to biochemistry after her first semester. Her MS thesis was on the ontogeny of peroxidase and catalase activities in a barley mutant lacking chlorophyll b under the tutelage of Prof. Trevor Robinson who specialized in plant biochemistry. After her MS, she chose Prof. Edward W. Westhead, an enzymologist, as her PhD adviser and worked on the lysine-sensitive aspartokinase of *Escherichia coli*. She and the other students would work way into the night, with Mae singing all night while working. "During our reminiscences, he (Dr. Westhead) said that he thought that the time of my stay in his lab was the happiest time there," shares Dr. Tecson-Mendoza. Her adviser wanted her to stay on for a postdoctoral fellowship, but she wanted to go home after being away for 5 years.

In November 1974, Mae returned to the Philippines after her graduate studies and served as an Assistant Professor at the Department of Biochemistry, UP College of Medicine until May 1976. There, she had the opportunity to work with NAST Ac. Solita Camara-Besa, who was the Chair of the Department of Biochemistry and Molecular Biology, and National Scientist Lourdes J. Cruz, who was starting her work on *Conus* toxins at that time.



During a meeting of the IPB Blochemistry Lab members and students.

At the Institute of Plant Breeding

In 1976, NAST Ac. Emil Q. Javier, then Director of the Institute of Plant Breeding (IPB), lured Dr. Evelyn Mae Tecson-Mendoza back to Los Baños to head the Biochemistry laboratory of IPB. Dr. Javier and National Scientist Dolores A. Ramirez were instrumental in allowing her laboratory to have the most complete basic biochemistry equipment and supplies and had been supportive of her researches.

Since June 1976, the IPB Biochemistry Laboratory has been home to Dr. Tecson-Mendoza and her pioneering researches in plant biochemistry and molecular biology. She led a team of researchers in elucidating basic knowledge in the fields of biochemistry of Philippine indigenous legumes, physicochemical, functional and nutritional properties of mungbean and coconut storage proteins and coconut oil-body proteins, and biochemical basis of the makapuno (mutant coconut) phenotype. Furthermore, she led the development of a transgenic papaya with longer shelf life, superior fruit qualities, and resistance to papaya ringspot virus (PRSV), the most economically important disease of papaya.

Nutritional and Anti-nutritional Factors in Indigenous Legumes and Mungbean: Biochemistry and Molecular Characterization and Improvement. The Philippines is endowed with rich genetic resources of food and feed legumes, several of which are underutilized. Dr. Tecson-Mendoza's pioneering researches on the biochemistry of indigenous legumes in the Philippines [2, 3] provided baseline information on these legumes' important biochemical and nutritional



With collaborating scientist, the late Professor Shigeru Utsumi, during his visit to IPB in 1997 after the FAOBMB Symposium in Manila, and Dr. RN Garcia.

qualities. Her work in this field is reported in 10 journal publications and a monograph. As these legumes are a major potential source of food, feed and livelihood, these studies provide a sound basis for the wider utilization of these relatively unknown and underutilized legumes.

More recently, Dr. Tecson-Mendoza has focused on the improvement of the physicochemical, functional, and nutritional properties of the major storage protein of mungbean, vicilin (the major isoform is called 8S α) for its greater utilization by using protein engineering technology. She started the program by studying the nature of mungbean proteins [4]. With students and staff, and the collaboration of Professor Shigeru Utsumi of Kyoto University, the work progressed immensely. The gene of the target protein, 8S α , was cloned and its molecular structure thoroughly studied [5]. Likewise, the recombinant 8S α was successfully expressed in *E. coli* and crystallized [5]. This second work led to the understanding of the physicochemical properties of both the native and the recombinant type of 8S α [6] and the elucidation of the crystal structure of the 8S α [7]. Knowledge of the crystal structure enabled the insertion of cysteine and methionine residues in the variable regions of the protein to enhance its functional and nutritional properties using protein engineering techniques [8, 9].

Biochemical Basis of Makapuno Mutant Coconut and its Gene Regulation. In the late 1970s, Dr. EM Tecson-Mendoza began her research on coconut by elucidating the biochemical basis of the mutant phenotype of coconut, the makapuno [10]. Makapuno means almost (for “maka”) full (“puno”) indicating that this coconut contains little or no water, but is nearly full of white, viscous, translucent jelly. Its meat or solid endosperm is soft and fluffy and becomes as firm as that of the normal coconut as it approaches the shell. Interest in the makapuno is attributed

primarily to its economic importance and its being another model system in the investigation of tumorigenesis in higher plants.

Dr. Tecson-Mendoza and her co-workers, and in collaboration with Dr. Dolores A. Ramirez, elucidated the cellular and biochemical basis [10, 11] of the makapuno phenotype, the mechanism and the involvement of the three key enzymes in carbohydrate metabolism in the expression of the makapuno phenotype [12, 13, 14]. A two-fold increase in galactomannans in the makapuno compared to the normal coconut was explained by the absence of α -galactosidase activity in the makapuno, while its high activity resulted in the accumulation of the mannans in the normal endosperm. The β -mannanase

also showed high activity in the makapuno endosperm. The low level of α -galactosidase in the makapuno and thus the inability to initiate the breakdown of galactomannans also explains why makapuno seed nuts do not germinate.

Coconut Storage and Oil-body Proteins. Recognizing the importance of basic research in coconut improvement, whether by conventional or genetic engineering methods, Dr. Tecson-Mendoza is making great strides in bringing coconut research into state-of-the-art knowledge at par with other oil seeds.

Dr. Tecson-Mendoza’s researches in coconut with colleagues and students include: (a) the determination of the variability in fatty acid and triacylglycerol composition of the oil of coconut hybrids and their parentals [15]), (b) the elucidation of the physicochemical and functional properties of coconut storage proteins [16, 17], with the discovery for the first time of the coconut 7S globulin [16], (c) the isolation and characterization of the coconut oil body and coconut oleosin [18,19], and (d) the cloning and characterization of the full length cDNAs of oleosin and cocosin [20,21].

Aside from contributing significantly to the meager coconut literature, these researches would be very useful in developing coconut as a new ingredient in food and non-food systems and provide baseline information on the oil profile of coconut varieties for breeding purposes.

Enhanced Solo Papaya. With a clear vision that modern biotechnology provides cutting-edge advantage, Dr. Tecson-Mendoza took the lead in its responsible use in crop improvement. In 1997, she and Dr. Violeta N. Villegas, former IPB Director and plant breeder, in collaboration with Dr. Jose Ramon Botella of the University of Queensland, led a team in developing transgenic Davao Solo papaya with longer shelf life

than the control nontransgenic papaya. This transgenic papaya was named Enhanced Solo. Transgenic plants bear fruits that ripen from 4 to 14 days after full yellow compared with nontransgenic control papayas that ripen 2 to 3 days after full yellow [22]. Biochemical analysis of the proximate composition showed similar values for transgenic and control fruits and the values were within those reported in the literature, indicating substantial equivalence between the transgenic and control papayas [23].

The Enhanced Solo team conducted the first field testing of a home-grown biotech crop in late March 2007. With Dr. Simeona V. Siar, co-project leader and plant breeder, the introduction of ringspot virus resistance into the transgenic papaya with delayed ripening trait by conventional breeding was started in 2007 by crossing the transgenic papaya with a backcross between *Carica papaya* and a wild relative, *Vasconcellea quercifolia*. Presently, the hybrids carrying both the delayed ripening gene and PRSV resistance are awaiting field testing under biosafety regulation.

Dr. Tecson-Mendoza attributes her success as a scientist to hard work and preparation, a solid academic background, and exemplary mentors. Her outstanding training as an independent researcher and ability to work as a team member, appreciation of the work of her fellow researchers and students, collaboration with other scientists, and institutional support also contributed to where she is now. Dr. Tecson-Mendoza is a firm believer in the value of collaboration and effective technology transfer by training where the expertise is. However, she insists that once learned and once facilities become available, such technologies should be practised in the local lab and taught to other researchers and students. Thus, the majority of the researches published by her lab members has been proudly undertaken in the country!

Promoting Science Education and Culture

Dr. Evelyn Mae Tecson-Mendoza is a dedicated science educator and is engaged in the building of the culture of science in the country. She actively promotes and advances the biomolecular sciences (biochemistry, molecular biology and biotechnology) education and research, especially as they relate to agriculture, in the Philippines for the improvement of the quality of education and life of the Filipino through science and technology. Her accomplishments in this noble undertaking are



Dr. Tecson-Mendoza and co-workers, from the left—Andy Sajise, Rudy Vergara and Dr. Toni Laurena, proudly marveling at the first transgenic papaya in the country.

as follows:

(a) Development of curricular programs. In recognition of her excellent leadership and ability to inspire people to work together to achieve a common goal, Dr. Tecson-Mendoza was chosen to lead various committees. (i) The UPLB MS and PhD Molecular Biology and Biotechnology programs were developed and instituted under the leadership of Dr. Tecson-Mendoza and approved by the UP Board of Regents in January 1999 and May 2002, respectively, for implementation. As chair, Dr. Tecson-Mendoza led the development of the overall program — determining the foundation, core courses, and other requirements of the program, the preparation of different courses, coordinating with more than 15 members of the committee (the largest perhaps in the university, the program being interdisciplinary) and more faculty as resource persons and proponents of different courses. (ii) The BS Biotechnology (Biological Engineering) Program at Mapua Institute of Technology was developed with the expert help given by Dr. Tecson-Mendoza to her Alma Mater and started in 2004. (iii) The BS Agricultural Biotechnology Program at UPLB College of Agriculture was developed with Dr. Tecson-Mendoza as chair of the committee. This program serves as a growth point of the UPLB College of Agriculture that will help sustain its leadership in agricultural education, research and extension in the country and in Southeast Asia. The offering of BS Agricultural Biotechnology started during the first semester SY 2010–2011.



Batch 2011 of the BS Agricultural Biotechnology program with Dr. Tecson-Mendoza and some members of the ABT Program Management Committee

(b) Development of courses. As major or co-proponent, she has developed courses such as: Biochemical Techniques (1975), Protein Chemistry (1995), Biocomputing, Advances in Transformation Biotechnology, Research Techniques in Molecular Biology II, Introduction to Agricultural Biotechnology, Principles and Applications of Agricultural Biotechnology, and a GE course — Exploring Biotechnology (2006–2009).

(c) Convenor/Organizer of seminar workshops/training. In the 1980s, she led the development and conduct of four training courses: one on laboratory techniques in biochemical education and research, and three on laboratory analyses, techniques and instrumentations held in different parts of the country under the aegis of the Philippine Biochemical Society (PBS) (now, the Philippine Society of Biochemistry and Molecular Biology). In 1987, as PBS President, she led the Biochemical Education Workshop co-sponsored by the International Union of Biochemistry. In the 1990s, she was a regular resource person and speaker in seed technology and genetic resources training programs to lecture on biochemical tools used in varietal identification, seed purity analysis, and biological diversity studies. More recently (2000s), she has been involved in the conduct of training in various molecular/biochemical techniques such as immunological techniques, blotting (DNA, RNA and protein), PCR-based techniques, cloning and transformation. In 2004, she initiated the training of high school teachers in the teaching of biotechnology as an activity of the National Academy of Science and Technology's (NAST) Philippine Science Heritage Center, where she also led the development of a biotechnology exhibit called *Bioteknolohiya!!*. She also chaired the 2007 NAST Annual Scientific Meeting and led various roundtable discussion activities on building a culture of science in the country by improving and strengthening science education. As president of the Kapisanan ng Kimika sa Pilipinas Southern Tagalog Chapter, she led the high school teachers' training in Chemistry project of

the society in 2010–2011.

(d) Speaker/Resource Person. Dr. Tecson-Mendoza has served as speaker in more than 150 conferences, fora, seminars, etc. on various aspects of biochemistry topics and techniques and biotechnology such as principles and applications, biosafety to environment, food and feed safety, ethics, intellectual property rights, bioindustry, biotechnology education, as well as on scientific writing and social responsibility of scientists, to different audiences - students, teachers, farmers, political leaders, the general public, all over the country.

(e) Teaching and mentoring BS, MS and PhD graduate students. Ma'am Mae, as her students fondly call Dr. Tecson-Mendoza, has mentored and graduated 10 PhD, 23 MS, and 36 BS students, and trained many more. She has taught at least ten different courses since 1974. Her students are well-placed in universities, in the government, and in the private sector, in national as well as international organizations.

Dr. Tecson-Mendoza is a very systematic but compassionate mentor. She always has time for her students and staff and encourages them to be creative and resourceful. Her students will always remember the occasional “snack time cum compre” moments with her — with the students returning to the workbench smiling and ready for the next task! She is a true friend, generous with her time and advice, a mentor par excellence!

Dr. Tecson-Mendoza also believes in the need to “institutionalize” mentoring to prepare the next generation of science professionals. Here are some of her ideas which could be studied and adopted to promote mentoring: (1) disseminate information on mentoring, the importance of preparing the next generation of science professionals, ethics in research, and mentoring and related matters through fora, publications, and the internet; (b) encourage our scientists to participate in this advocacy to promote mentoring; and (c) include mentoring as part of lectures in our courses in seminars, research methods, and other courses. Both students and mentors should be made aware of, understand and appreciate the duties and responsibilities of trainees and mentors, the ethics of conducting research and mentoring, and the role of mentoring in building a culture of science in our country.

(f). Development of teaching/learning materials. (i) A book “Understanding Biotechnology” and a tutorial in CD format “Biotech Tutorial CD” authored by Dr. Tecson-Mendoza were published by the NAST-PSHC Foundation, Inc. and have been distributed to teachers and regulators who have attended

various biotechnology workshops, as well as ordered by several schools and private companies for their use. (ii) The *Bioteknolohiya!!* at NAST-PSHC also serves as a learning resource for the thousands of school children and teachers who visit the center. She has adeptly harnessed her ability to popularize science and technology to increase awareness and understanding among the young and the general public.

Participation in the Development and Review of National R & D Programs and Policy Studies

As Deputy Director of the Institute of Plant Breeding (1985–1989) during the term of Acad. E.T. Rasco Jr. as director, Dr. Tecson-Mendoza was involved in top level development of research programs at IPB and their implementation. She was part of a team with Dr. Rasco which developed a national program for strengthening the crop varietal improvement and seed development program of the Philippines in 1990. Dr. Tecson-Mendoza participated in drafting important bills that were approved into laws, namely, the Seed Industry Development Act of 1992 and the Philippine Plant Variety Protection Act of 2002. In 1989, she was part of a team that assessed the needs of an R & D unit for seed development for Central Luzon, Philippines. She served as overall chair of the extensive internal and external reviews of IPB in 1990 which drew national and international experts and resulted in the ten-year program (1991–2000) of IPB, in preparation for the new millennium. Further, Dr. Tecson-Mendoza was actively involved in setting basic minimum requirements for national research centers from 1989–1992 with a national team of experts and in assessing the sugarcane industry in 1996 with Acad. Ruben L. Villareal as team leader and Drs. Artemio Salazar and Randy Hautea.

In 1996–1998, she served as leader for the crops sector that crafted the National Agriculture and Environment Biotechnology Research and Development Team of PCARRD-DOST in 1996–1998. She led the team's consultation with different crop team leaders and researchers on assessment and prioritization of research problems amenable to biotechnology, assessment of manpower and physical resources and facilities, after which the crop biotechnology R & D program was developed and packaged. This research program worth PhP65M was presented by Acad. William G. Padolina, then the Department of Science and Technology (DOST) Secretary, to President Fidel V. Ramos, who subsequently approved the program. In 2006, she and Acad. Rafael Guerrero as members and Dr. Saturnina C. Halos as team leader reviewed the biotechnology researches and needs in agriculture and crafted the Department of Agriculture Biotechnology Program 2006–2016. As focal person of NAST in biotechnology, Dr. Tecson-Mendoza was involved in the preparation of resolutions on biotechnology presented to the Philippine government. In 2007, NAST tasked Dr. Tecson-Mendoza to lead the review of the biosafety regulations in the country in response to the request of the National Committee on Biosafety of the Philippines.

More recently in 2010, she teamed up with colleagues Professors V.O. Espaldon, J.V. Camacho Jr., L.C. Carascal and W.B. Carada from various colleges of UPLB in the conduct of an extensive and comprehensive study on building an inter-, cross-, and transdisciplinary research culture in UPLB. This centennial professorial lecture proposed the *UPLB Transform* program towards building UPLB as a true research university. This consists of four reinforcing programs: Institution reform towards building a research university; Student- and research-centered undergraduate education; Inter-, cross- and transdisciplinary graduate education; and Integrated research and extension program.

Editorship of Scientific Journals

Dr. Tecson-Mendoza was editor-in-chief of the Philippine Journal of Crop Science for 18 years (1983–2000), the Bulletin of the Philippine Society of Biochemistry (1990–1991) and the Bulletin of the Philippine Society of Biochemistry and Molecular Biology (1994–1995). In 2004, she was appointed as editor-in-chief of the Philippine Agricultural Scientist (PAS), the official journal of the UPLB College of Agriculture, a position she held up to 2009. During this period, she streamlined the operations of the journal for better efficiency and aligned them to international standards. She launched the website of PAS in 2005, had the cover and logo redesigned and started the use of the acronym PAS for better recall. Submission and processing of papers were started to be done by email. Reviewers were invited from beyond Philippine shores. With the help of its honorary advisory board composed of National Scientists at UPLB, its international board of editors and the efficient and competent PAS staff, the journal maintained or even upped its quality. By 2009, PAS had become truly an international journal with 75% of published articles coming from different parts of the world. To mark the centennial of the College of Agriculture and the PAS, two special issues of the PAS were prepared under her leadership in 2010–2011: one consisting of the indices of all volumes of PAS and its complete first volume in digital form and the second consisting of pioneering and outstanding papers published in PAS. In March 2007, Dr. Tecson-Mendoza was invited to be an overseas editor of Bioscience, Biotechnology and Biochemistry, published by the Japan Society for Bioscience, Biotechnology and Agrochemistry and she actively serves said position to date.

Recognition and Awards

In recognition of her outstanding contributions in the field of chemistry/biochemistry, Dr. Evelyn Mae Tecson-Mendoza has received numerous institutional and national awards some of which are as follows: In 1984, she was named the Outstanding Young Scientist in Chemistry by the National Academy of Science and Technology. She was awarded the NRCP Achievement Award in Chemistry in 1988 and was selected one of the Outstanding Women in the Nation's Service (TOWNS) in 1989. Her outstanding contributions to science and technology have been recognized by national and professional organizations.

Her research team has likewise reaped awards such as: 50 Great Men and Women of Science, DOST, 2008; Regional Winner, CHED-HEI Outstanding Research Program, CHED, 2008 and Outstanding Research Team of UPLB, 2009. In 2009, she was conferred the rank of UP Scientist III, the highest recognition of scientific productivity by the University of the Philippines System, and in 2011, the Concepcion D. Dadufalza Award for Distinguished Achievement, also from the UP System.

In 1992, Dr. Evelyn Mae Tecson-Mendoza was elected Academician in the National Academy of Science and Technology, where she presently serves as Secretary of the Executive Council and Chair of the Chemical, Mathematical and Physical Sciences Division.

Transcending Beyond Science

Forever keen for opportunities, Dr. Tecson-Mendoza boldly ventured into introducing the concepts and applications of entrepreneurship into the consciousness of the highly science-motivated UPLB. In her MBB 291 course, she and Prof. Sonny Arrienda teach the rigors of entrepreneurship through business plan preparation. She facilitates the identification of UPLB mature technologies which are marketable. Discussions between the MBB 291 students and a technology developer attempt to identify the best business model that would bring the highest "return-on-investment". The business plan based on her team's research on Enhanced Solo papaya was developed by the then undergraduate student, Perrose Comendador, who was mentored by Prof. Arrienda; it won the grand prize in the first Philippine Emerging Start-Ups Open (PESO) challenge in 2005. Dr. Tecson-Mendoza believes that interphasing science and technology with commercialization would greatly benefit the general public, bring the technology developer just rewards, and further advance S & T in the country.

To Dr. Evelyn Mae Tecson-Mendoza, sound science is not an end but it is the means to improve lives. Her challenge to the Filipino scientists is to serve the Filipino nation and elevate it amongst the world's leaders in science and technology. To the Filipino students here and abroad, she advises: Serve your country here where you are needed most!

ACKNOWLEDGEMENT

The help of Trina Leah T. Mendoza in writing this article is gratefully acknowledged.

REFERENCES

[1] Tecson EMS, Esmama BV, Lontoc LP, Juliano BO. Studies on the extraction and composition of rice endosperm glutelin and prolamin. *Cereal Chem* 1971; 48:168.
 [2] Tecson-Mendoza EM, Rodriguez FM, Revilla JM, Laurena AC. *Biochemistry of Philippine Indigenous Legumes*. National Academy of Science and Technology

Philippines, Manila 2003; 106 pp.
 [3] Tecson-Mendoza EM. Development of functional foods in the Philippines. *Food Sci Technol Res* 2007; 13:179-186.
 [4] Tecson-Mendoza EM, Adachi M, Bernardo AEN, Utsumi S. Mungbean (*Vigna radiata* (L.) Wilczek) Globulins: Purification and characterization. *J Agric Food Chem* 2001; 49:1552-1558.
 [5] Bernardo AEN, Garcia RN, Adachi M, Angeles JGC, Kaga A, Ishimoto M, Utsumi S, Tecson-Mendoza EM. 8S Globulin of mungbean [*Vigna radiata* (L.) Wilczek]: Cloning and characterization of its cDNA isoforms, expression in *Escherichia coli*, purification, and crystallization of the major recombinant 8S isoform. *J Agric Food Chem* 2004; 52:2552-2560.
 [6] Garcia RN, Adachi M, Tecson-Mendoza EM, Bernardo AEN, Utsumi S. Physicochemical properties of native and recombinant mungbean (*Vigna radiata* L. Wilczek) 8S globulins and the effects of the N-linked glycans. *J Food Agric Chem* 2006; 54:6005-6010.
 [7] Itoh T, Garcia RN, Adachi M, Maruyama Y, Tecson-Mendoza EM, Mikami B, Utsumi S. Crystal structure of 8S α globulin, the major seed storage protein of mungbean. *Acta Cryst* 2006; D62:824-832.
 [8] Torio MA, Adachi M, Garcia RN, Prak K, Maruyama N, Utsumi S, Tecson-Mendoza EM. Effects of engineered methionine in the 8S [α] globulin of mungbean on its physicochemical and functional properties and potential nutritional quality. *Food Res Internat* 2011; 44:2984-2990. doi:10.1016/j.foodres.2011.07.010.
 [9] Torio MA, Itoh T, Garcia RN, Maruyama N, Utsumi S, Tecson-Mendoza EM. Introduction of sulfhydryl groups and disulfide linkage to mungbean 8S α globulin and effects on physicochemical and functional properties. *Food Res Internat* 2012; 45:277-282. doi:10.1016/j.foodres.2011.10.044.
 [10] Ramirez DA, Mendoza EMT. The Makapuno Mutant Coconut. *The National Academy of Science and Technology (Phil)*. 1998; 66 pp.
 [11] Sebastian LS, Mujer CV, Mendoza EMT. A Comparative cytochemical study of mature makapuno and normal coconut endosperms. *Philipp J Coconut Studies* 1987; 12(1):14-22.
 [12] Mujer CV, Ramirez DA, Mendoza EMT. α -D-Galactosidase deficiency in coconut endosperm: Its possible pleiotropic effects in makapuno. *Phytochemistry* 1984a; 22:893-894.
 [13] Mujer CV, Ramirez DA, Mendoza EMT. Coconut α -D-galactosidase isoenzymes: Isolation purification and characterization. *Phytochemistry* 1984b; 23:1251-1254.
 [14] Samonte JL, Mendoza EMT, Ilag LL, dela Cruz NB, Ramirez DA. Galactomannan degrading enzymes in maturing normal and makapuno and germinating normal coconut endosperms. *Phytochemistry* 1989;

- 28:2269-2273.
- [15] Laureles LR, Rodriguez FM, Reaño CE, Santos GA, Laurena AC, Tecson-Mendoza EM. Variability in fatty acid and triacylglycerol composition of the oil of coconut (*Cocos nucifera* L.) hybrids and their parentals. *J Agric Food Chem* 2002; 50:1581-1586.
- [16] Garcia RN, Arocena RV, Laurena AC, Tecson-Mendoza EM. The 11S and 7S globulins of coconut (*Cocos nucifera* L.): Purification and characterization. *J Agric Food Chem* 2005; 53:1734-1739.
- [17] Angelia MRN, Garcia RN, Caldo KMP, Prak K, Utsumi S, Tecson-Mendoza EM. Physicochemical and Functional Characterization of Cocosin, the Coconut 11S Globulin. *Food Sci Technol* 2010; 16:225–232.
- [18] Rodelas AJD, Regalado ES, Bela-Ong D, Garcia RN, Laurena AC, Tecson-Mendoza EM. Isolation and characterization of the oil bodies and oleosin of coconut (*Cocos nucifera* L.). *Philipp Agric Sci* 2008; 91:389- 394.
- [19] Regalado ES, Angeles JGC, Rodelas AJD, Garcia RN, Laurena AC, Tecson-Mendoza EM. Cloning and characterization of the oleosin cDNA isoforms from coconut (*Cocos nucifera* L.). *Philipp Agric Sci* 2008; 91:287-294.
- [20] Vargas AG, Cabanos CS, Garcia RN, Maruyama N, Tecson-Mendoza EM. Cloning, molecular analysis and developmental expression of the oleosin cDNA isoforms in coconut (*Cocos nucifera* L.). 2012; For submission.
- [21] Caldo KMP, Garcia RN, Tecson-Mendoza EM. Cloning, molecular analysis and developmental expression of the coconut (*Cocos nucifera* L.) 11S globulin gene. 2012; For submission.
- [22] Tecson-Mendoza EM, Laurena AC, Botella JR. Recent advances in the development of transgenic papaya technology. *Biotechnol Annu Rev* 2008; 14:423-462.
- [23] Cabanos CS, Sajise AG, Garcia RN, Siar SV, Tecson-Mendoza EM. Compositional analysis of transgenic papaya with delayed ripening trait. 2012; For submission.