# ANNUAL RESEARCH REPORT 2012



VOLUME XVIII

# **CAMS RESEARCH 2012**

# **FACTS & FIGURES**

- 2,702,111 RO Total Budget
- 68 Research Projects in Total
  - 37 Internal Grant Projects (7 awarded in 2012)
  - 8 Strategic Projects
  - 23 Externally-Funded Projects (8 awarded in 2012)
- 268 Publications
  - **o 99 Refereed Journals**
  - 8 Books (7 edited)
  - 31 Chapter in Books
  - 108 Conference Presentations-(proceedings – 21; papers presented – 69; posters – 14; abstracts – 4)
  - o 21 Technical Reports
  - 1 Booklet



## Annual Research Report 2012

Volume XVIII

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### Foreword

The College of Agricultural and Marine Sciences articulates its research according to its objective "to utilize terrestrial and marine resources in a sustainable and profitable manner resulting in positive impacts for Omani society and the international academic community." The following pages outline the effort of our faculty, members of staff and students towards this strategic objective during 2012.

The diversification of research funding initiated in 2010 and 2011 continued with an increase in the contribution of external research funding. New research projects funded by The Research Council of Oman, the Agriculture and Fisheries Development Fund, consultancy and contract research, etc. represent now OR 468,000 or 85% of the College research funding.

The year 2012 saw the completion of several projects on Plant and Animal Genetic Resources, Kingfish Management, Characterization of Plant Diseases, Evaluation of Fish-extracted Gelatins, Heavy Metals Contamination of Shellfish, and many others. This once more illustrates the diversity of the research interests at CAMS and the naturally multidisciplinary basis of agricultural and marine research. The increasing number of new research projects supports our vision to become a leader in agricultural and marine research and education in the region. In 2012 CAMS published a total of 99 refereed journal papers, more than 39 books and book chapters and CAMS faculty and staff presented 108 conference papers. The total number of scientific publications in the College was 268.

The research outlines and list of research papers presented in this report illustrates the breadth of research work being conducted at CAMS. On the other hand, it does not reflect the wide variety of people that support this research activity: scientific collaborators in and outside of Oman, administrators, students and graduate students, research assistants, sometimes volunteers, industrial partners; we are, as always, grateful to these partners inside and outside SQU.

Michel R. Claereboudt Assistant Dean for Postgraduate Studies and Research

# Research Committee (2012)

- Dr. Michel Claereboudt, Chair
- Prof. Osman Mahgoub Gaafar
- Dr. Abdullah Al-Sa'di
- Dr. Mostafa Waly
- Dr. Sergey Piontkovski
- Dr. Slim Zekri
- Dr. Manickavasagan Annamalai

# The Year in Review

## Introduction

Research is in constant evolution but remains a strong "leg" of CAMS three-legged chair: research, education and services. We, in the Research Committee would like through this report to illustrate both the research "input" of the College and its "output" to the scientific community. From an input standpoint, the total amount of funds competitively earned by CAMS faculty and staff has reached a relatively stable value varying between half a million OR to 700,000 OR of awarded funds every year. Interestingly, the contribution of funds obtained from sources outside of SQU increases regularly: from 57% in 2010, to 76% in 2011 to 85% in 2012. The number of publications in the College has now reached 99 refereed journal papers per year and a total of 268 publications were authored by 62 faculty, staff and students in 2012. Out of these, 108 were presented at various conferences. We have implemented a database system (Endnote) in which all publications are progressively entered and automatically formatted, counted etc. according to the request of the end-users.

### **Research Projects and Budgets**

III 2012.			
Source of Fund	No. of Proj	Budget (RO)	Total (RO)
SQU Internal Grants			263,195
Awarded in 2012	7	70,000	
Ongoing	17	99,900	
Completed in 2012	13	93,295	
His Majesty's Trust Fund			745,800
Ongoing	4	342,000	
Completed in 2012	4	403,800	
The Research Council			882,200
Awarded in 2012	2	304,350	
Ongoing	4	577,850	
Contract Research			70,184
Awarded in 2012	3	51,880	
Awarded in 2012 & completed in the same yr	1	7,990	
Awarded from previous yrs & completed in 2012	2	10,314	
External Grants			740,732
Awarded in 2012	3	112,448	
Ongoing	5	502,404	
Awarded from previous yrs & completed in 2012	3	125,880	
Total	68		2,702,111

**Table 1.** Summary of research and development projects held by the College in 2012.

### **Internal Grant Research and Development Projects**

No.	Title of Research	Principal Investigator	Amount (RO)
1	Identification of camel meat quality para- meters using proteomics	I. Kadim	10,250
2	Utilization of <i>Prosopis juliflora</i> for feeding Omani livestock	O.M. Gaafar	8,850
3	Influence of crop duration and grafting on crop productivity and quality in greenhouse cucumber	F. Al-Said	8,850
4	Bioactive compounds from Oman marine organisms	S. Dobretsov	10,250
5	Feasibility of soft-coral and sea-cucumber identification using fluid particle imaging and automated shape analysis	M. Claereboudt	9,000
6	Evaluation of the effect of soil compaction and tillage management on the growth and yield of crops	H. Jayasuriya	8,550
7	Computer simulation model for improving wheat production	Y. Al Mulla	10,250
		Total	70,000

**Table 2.** Internally-funded research and development projects awarded in 2012.

Table 3.	Ongoing	internally	-funded	research	and	developmen	nt projects	in	2012.
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No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Effect of thermal processing and enzyme supplementation on the nutritive value of local agricultural by-products as feed ingredients in chicken diets	2008	W. Al Marzooqi	11,500
2	<i>Escherishia coli</i> 0157:H7 and other Shiga toxin-producing <i>E. coli</i> in the facces of healthy sheep, goats and cattle in the Sultanate of Oman	2010	D. Al Ajmi	4,000
3	Diabetes education in primary health care in Oman: factors predicting diabetes control, effect on knowledge and metabolic control	2010	L. Al-Subhi	6,400
4	A supply chain management approach to promoting competitive advantage of small-scale fishery sector in Oman	2010	O. Al Jabri	4,000

Table 3 ....

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)	
5	Performance evaluation of a solar tunnel dryer for drying of lemons in Oman	2010	M.A. Basunia	4,000	
6	Comparative oxidase respiratory burst and phagocytosis of neonatal and adult ovine polymorphonu- clear leuokocytes	2011	E. Johnson	6,000	
7	Extraction and value addition to Omani basil oil	2011	A. Al-Maskri	6,500	
8	An analysis on optimal plan on new-planting and re-planting of date palm in Oman through a multiperiod linear programming optimization model	2011	H. Kotagama	3,500	
9	Glycemic index and glycemic load of traditional Omani foods: studies on the effects of methodological and food factors	2011	A. Ali	8,000	
10	Screening novel biomarkers for early detection of autism in Omani children	2011	M. Essa	8,000	
11	Biochemical, physiochemical and microbial characteristics stability of traditionally dried <i>E. punctifer</i> in Oman during ambient storage	2011	I. Al-Bulushi	6,000	
12	Physicochemical properties and antimicrobial activity of Omani frankincense	2011	M.S. Rahman	4,000	
13	Aroma profile of pasteurized camel milk	2011	Z. Al-Attabi	3,000	
14	Catching and economic performance of the demersal longline fishery	2011	H. Al-Masroori	6,000	
15	Plant-soil approach for irrigation scheduling of fruit crops	2011	S. Al-Jabri	8,000	
16	Nutrification of traditional foods with Omani dates	2011	M. Annamalai	6,000	
17	Possibility of utilization solar stills to provide greenhouse water demand in arid environments	2011	A. Al-Ismaili	5,000	
			Total	99,900	

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Reduction of post-harvest losses and improvement of fish handling systems in Oman	2007	S. Al-Jufaili	4,995
2	Investigation on <i>Brucella meliten-sis</i> immunogenic domains	2008	Y. ElTahir	12,000
3	Molecular characterization of Begomovirus associated with tomato and other crops and screening of tomato cultivars tolerant to tomato yellow leaf curl virus	2009	A.J. Khan	10,000
4	Causal agents of melon sudden decline in Oman	2009	M. Deadman	10,000
5	Design and construction of green- houses for arid regions: Phase 2	2009	Y. Al-Mulla	4,900
6	Study on Theileriosis of indigenous sheep in the Sultanate of Oman	2010	M. Tageldin	8,400
7	Integrated management of the Dubas bug: fundamental investi- gation in biological, cultural, and chemical control	2010	A.K. Al Wahaibi	6,000
8	A study of the nutritional and metabolic factors contributing to the occurrence of autistic spectrum disorders among children in the Sultanate of Oman	2010	M. Waly	8,000
9	Extraction and structural characte- rization of gelatin from fish skin	2010	M.S. Rahman	8,000
10	Assessing the impact of global food crisis on food security in Oman	2010	H. Boughanmi	4,000
11	Effects of siltation behind Al-Khod Dam on the soil proper-ties and recharge efficiency	2010	A.K. Al Maktoumi	6,000
12	Optimal control of micro irrigation systems	2010	H. AbdelRahman	6,000
13	Agronomic and economic feasibility of salt tolerant plants for saline lands and water of Batinah	2010	A. Al-Busaidi	5,000
			Total	93,295

**Table 4.** Internally-funded research and development projects completed in2012.

## His Majesty's Strategic Research Projects

**Table 5.** Ongoing research projects in 2012 funded through His Majesty's Trust Fund (HMTF).

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Feasibility of managed aquifer recharge using excess treated wastewater in Oman	2009	M. Ahmed	85,000
2	Potential sources of soil-borne plant pathogenic fungi and bacteria into farms in Oman	2010	A. Al-Sadi	87,500
3	Economical, social and environ- mental impacts of marine biofouling in the Sultanate of Oman	2010	S. Dobretsov	80,000
4	Value added functional products from less utilized biomaterials locally available in the Sultanate	2011	M.S. Rahman	89,500
			Total	342,000

	Table 6	5.	Research	projects	complete	d in	2012	funded	through	HMTF.
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No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Conservation and utilization of plant genetic resources in Oman	2007	N. Al-Saady	144,000
2	Rejuvenating lime and mango production in Oman: Resolving current challenges	2008	R. Al-Yahyai	100,000
3	Characterization, evaluation and conservation of indigenous animal genetic resources in the Sultanate of Oman	2008	O. M. Gaafar	80,000
4	Stock assessment of Kingfish	2008	A. Govender	79,800
			Total	403,800

### **Externally-Funded Research Projects**

The externally-funded research involved collaborations with The Research Council in Oman (TRC); Ministry of Agriculture (MoA); Ministry of Fisheries Wealth (MFW); Royal Court Affairs, Oman; Industrial Innovation Center (IIC) Oman; International Center for Biosaline Agriculture (ICBA); International Islamic University, Malaysia (IIUM) and other private institutions.

No.	Title	Principal Investigator	Sponsor/ Agency	Amount (RO)
1	Numerical modeling of ocean circulation to investigate the regional marine environment and climate around Sultanate of Oman	Y.V.B. Sarma	TRC	131,000
2	Monitoring roundwater using energy water smart meters and precision irrigation	S. Zekri	TRC	173,350
			Total	304,350

Table 7.	Research	projects	awarded	in	2012	funded	by	TRC,	Oman
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Table 8.	Ongoing 1	research	projects	in 2012	funded	by TRC,	Oman.
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No	. Title	Principal Investigator	Year Granted	Amount (RO)
1	Oceanographical regime shift in the Sea of Oman	S. Piontkovski	2010	146,000
2	Molecular characterization of begomovirus associated with tomato and other crops and screening of tomato cultivars tolerant to leaf curl virus	A.J. Khan	2010	132,000
3	Effect of dietary supplementation of fruits grown in Oman on cognitive decline in alzheimer's dementia, mild cognitive impairment, vascular cognitive impairment and traumatic brain injury	M. Essa	2011	201,000
4	Development of Computer Vision (CV) technology for quality assess- ment of Dates in Oman	M. Annamalai	2011	98,850
			Total	577,850

No.	Title	Principal Investigator	Sponsor/ Agency	Amount (RO)
1	Wastewater Treatment Reuse at A'Saffa Poultry Farm at Thamrait, Dhofar Governance	M. Ahmed	IIC, Oman/ A'Saffa	20,400
2	Evaluation and Assessment of Treated Sludge (KALA Fertilizer) Application in Agriculture	A. Al-Busaidi	Haya Water	27,000
3	Whole wheat products development and awareness creation in Oman – Phases IV to VI	M. Annamalai	IIC, Oman	4,480
			Total	51,880

Table 9. Contract research awarded in 2012.

**Table 10.** Contract research awarded in 2012 and completed in the same year.

No.	Title	Principal Investigator	Sponsor/ Agency	Amount (RO)
1	Development of a Marine Habitat Enhancement Strategy for Musandam Gaz Processing Plant – Phase I	M. Claereboudt	Oman Oil E&P Co. LLC	7.990
			Total	7,990

Table	11.	Contract	research	awarded	from	previous	years	and	completed	in
2012.										

No.	Title	Principal Investigator	Year Granted	Sponsor/ Agency	Amount (RO)
1	National strategy to combat salinity and protect water resources from pollution	S. Zekri	2010	ICBA	2,814
2	Detection of <i>Citrus</i> <i>exocortis</i> viroid, <i>Citrus</i> <i>cachexia</i> viroid and Citrus greening bacteria by PCR assays in citrus trees from Royal Gardens and Farms	A.J. Khan	2009	Royal Court Affairs, Oman	7,500
				Total	10,314

No.	Title	Principal Investigator	Sponsor/ Agency	Amount (RO)
1	Role of nurseries and propagation techniques in spreading citrus pathogens	A.M. Al-Sadi	VALE Brazil through Univ of Federal Viscosa, Brazil	29,948
2	Studies on Citrus Diseases Caused by Citrus Tristeza Virus (CTV), Phytoplasma and Viroid in Oman	A. Al Sadi	VALE Oman Pelletizing Co., LLC	47,500
3	Mango wilt disease in Oman: Resistance, resistance mechanisms and environmental interactions	M.L. Deadman	VALE Oman Pelletizing Co., LLC	35,000
			Total	112,448

 Table 12. Research projects awarded in 2012 funded through external grants.

**Table13.** Ongoing research projects awarded from previous years funded through external grants.

No.	Title	Principal Investigator	Year Granted	Sponsor/ Agency	Amount (RO)
1	Diversity, stocks and feasibility of sea-cucumber aquaculture in Oman	K. Al-Rashdi M. Claereboudt	2008	MFW	94,300
2	Assessments of mesoscale physical-biological interactions along the coast of Oman as the basis for understanding the periodic fisheries losses	A.Al-Azri	2009	MFW	222,900
3	Development of low fat and low sugar Omani halwa	M.S. Rahman	2011	IIC, Oman	4,924
4	Whole wheat products development and awareness creation in Oman – Phases II & III	M. Annamalai	2011	IIC, Oman	15,780
5	Determination of chemical contaminates of meat and meat products which threaten human health sold in Oman	I. Kadim	2011	MoA	164,500
				Total	502,404

No.	Title	Principal Investigator	Year Granted	Sponsor/ Agency	Amount (RO)
1	Assessment of shark population movements, delineations and breeding grounds in the Sultanate of Oman	A. Henderson	2008	MFW	100,000
2	Heavy metal contamination of fish and shellfish	S. Goddard S. Al-Barwani	2009	IIUM	14,400
3	Whole wheat products development and awareness creation in Oman – Phase I	M. Annamalai	2011	IIC, Oman	11,480
				Total	125,880

**Table 14.** Ongoing research projects awarded from previous years andcompleted in 2012 funded through external grants.

# UNIVERSITY DAY May 2, 2012

# Oral Presentations *by* PhD Students

#### **Microbial Communities on Antifouling Paints**

#### Thirumahal T. Muthukrishnan

Department of Marine Science & Fisheries

Artificial surfaces in the marine environment are quickly colonized by microorganisms resulting in the formation of biofilms which induce or inhibit the settlement of marine invertebrate larvae. Approaches to control this multistage process of biofouling include the use of several types of antifouling marine coatings. However, not much is known about their effectiveness in preventing microbial attachment. This preliminary study aims at qualitative and quantitative comparison of microbial communities developed on four different types of antifouling coatings submerged at two different locations in Oman. Zinc-based, copper-based, copper and zinc-based and silicone-based coatings were applied onto plastic slides. Slides without any coating were used as controls. Microbial biofilms were harvested after 2, 7 and 14 days of immersion. Bacterial densities were analyzed using epifluorescence microscopy and biomass of photosynthetic organisms was estimated using chlorophyll a concentrations. The differential performance of tested antifouling coatings observed in both locations may be attributed to several factors including varying environmental conditions, difference in biofouling communities, time of exposure and physical and chemical properties of antifouling coatings. The temporal and spatial changes of microbial communities on these coatings will be assessed using molecular techniques such as 454 pyrosequencing and automated ribosomal intergenic spacer analysis.

#### Comparative Analysis of Total Phenolics, Flavonoid Content and Antioxidant Profile of Different Date Varieties (Phoenix dactylifera L.) from Sultanate of Oman

#### Vandita Singh, Musthafa Mohd Essa, Nejib Guizani, Mohd Shafiur Rahman

Department of Food Science & Nutrition

The present study investigates the comparative antioxidant ability of the date fruits (DF's) (Phoenix dactylifera) of three major date palm varieties such as Fardh, Khasab and Khalas grown in the Sultanate of Oman at two edible maturation stages, namely Rutab (fresh) and Tamr (dried). Antioxidant ability was assessed by using Trolox equivalent antioxidant capacity (TEAC), 2, 2azinobis (3-ethyl benzo thiazoline-6-sulphonic acid) radical cation (ABTS+), 2,2-diphenyl-1-picrylhydrazyl (DPPH), Superoxideradical scavenging (SRSA), ferric reducing/anti-oxidant power (FRAP assay), Total reducing power ability (TRPA) and Metal chelation assays. The total phenolic content (TPC) and total flavonoid content (TFC) of the DF's were also quantified. The total phenolic content (TPC) of all three varieties at Rutab and Tamr stages ranged from 81-178 and 194-234 mg gallic acid equivalents (GAE) / 100g of DW and total flavanoid content (TFC) ranged from 19-66 and 25-34 mg catechin equivalents (CEQ)/100g of DW, respectively. The % inhibition in ABTS assay of all three varieties of DF's at Rutab and Tamr stages ranges from 80-92 % and 84-92 % and the % inhibition of DF's at Rutab and Tamr stages ranges from 63-65 % and 70-73 %. respectively observed from DPPH assay. Whereas, in SRSA, % inhibition of DF's at Rutab and Tamr stages ranges from 34-43 % and 29-44 %, respectively. The % chelating effect of all three varieties of DF's at Rutab and Tamr stages was 93% and 80-87%, respectively. The observed antioxidant ability of DF's may be due to abundant presence of phenolic contents and high electron donating ability to neutralize free radicals. Overall, the fardh variety showed significant antioxidant ability and phenolic contents than other varieties at different stages.

#### The Importance of Conventional Breeding and Molecular Assisted Selection in Improving Plant Traits

#### Aadel Al-Shihi

Department of Crop Sciences

Since thousands of years, farmers used to select the best looking plants and seeds and saved them to plant for the next season. Then, once the science of genetics became better understood, plant breeders used what they knew about the genes of a plant to select for specific desirable traits to develop improved varieties. These features like faster growth, higher yields, pest and disease resistance, larger seeds, or sweeter fruits. Conventional plant breeding has been going on for hundreds of years, and is still used today. Desirable characteristics from parent plants could also be combined in the offspring. The plant breeders achieve some results such as yield improvement, extended growing season and improvement of quality. Traditionally, plant breeders have selected plants based on their visible traits, called the phenotype. This process can be difficult, slow and influenced by the environment. Now, plant breeders use marker-assisted selection (MAS), molecular markers are used for identifying specific genes of the interest in the plant. The scientists create the genetic linkage map which can easily determine the location of genes and markers and their distance from other genes. Several marker systems have been developed and are applied to a range of crop species. These are the Restriction Fragment Length Polymorphisms (RFLPs), Random Amplification of Polymorphic DNAs (RAPDs), Sequence Tagged Sites (STS), Amplified Fragment Length Polymorphisms (AFLPs), Simple Sequence Repeats (SSRs) and others. These markers have been widely used to monitor differences in DNA sequence in and among species. They allow the creation of new sources of genetic variation by introducing new and desirable traits from wild varieties into elite lines.

#### Begomoviruses and their RNA Silencing Suppressors

#### AbdulRahman Al Matroushi

Department of Crop Sciences

Begomovirus is a large genus having 80% of the viruses in the family of geminivirideae. They are transmitted by whitefly Bemisia tabaci. Their circular single-stranded (ssDNA) genomes that multiply in nuclei, are organized in one or two molecules of about 2.7 kb each. DNA component of monopartite begomoviruses or DNA-A of bi-partite encodes six genes (AV1, AV2, AC1, AC2, AC3 and AC4). Many monopartite begomoviruses are associated with betasatellite that encodes one open reading frame ( $\beta$ C1). They can cause considerable damage to cultivated dicotyledonous plants in subtropical-tropical and mild temperate regions. Tomato yellow leaf curl begomovirus is the most destructive pest of tomato in Oman. The deployment of host-plant resistance is the most desirable mean to control begomoviral diseases. The plants used RNA silencing as an antiviral defense strategy. They have at least three silencing cytoplasmic RNA pathways. These are silencing or posttranscriptional gene silencing (PTGS) mediated by small interfering RNA (siRNA), silencing mediated by microRNAs (miRNAs) and transcriptional gene silencing (TGS) mediated by siRNA-directed methylation of DNA and histone proteins. Moreover, begomoviruses are the inducer of RNA silencing to regulate its own replication. Begomoviruses acquired a variety of unrelated suppressors that affect all three silencing pathways. However, these suppressors are not equally effective in different begomovirus species or in different hosts. Three genes of begomovirus namely, AV2, AC2 and AC4 as well as the  $\beta$ C1 of the associated DNA- $\beta$  function as suppressors of RNA silencing. It is believed that AV2 suppresses cytoplasmic RNA silencing (PTGS). AC2 appears to target both cytoplasmic RNA silencing and siRNA-directed DNA methylation. Whereas, AC4 and possibly  $\beta C1$ , suppress cytoplasmic RNA silencing and the miRNA pathway. Hence, begomoviruses can use the recombination strategies to replicate, suppressors can be acquired. Therefore, RNA silencing strategies to control begomoviruses has to be studied well and applied with precautions.

#### Genetically Engineered Resistance to Begomovirus Associated with Tomato in Oman

#### Um-e-Ammara

#### Department of Crop Sciences

Plant viruses are comprised of two major groups; RNA and DNA viruses. Geminiviruses are plant single stranded DNA (ssDNA) viruses transmitted by whiteflies, leafhoppers, treehoppers that can cause infection to a wide range of hosts including both monocots and dicots resulting in significant yield losses which may reach to 0-100% depending on management practices around the globe. New geminiviruses are continuously emerging through recombination or pseudo-recombination among strains and/or species in various crops. There is a dire need to device strategies to control these ever evolving organisms and genetic engineering could be an effective technique that can solve many of the problems and drawbacks of conventional breeding. In the past, most of these have involved pathogen-derived resistance strategies such as the expression of mutant or truncated viral proteins that interfere with virus infection, or transcription of viral RNA sequences that silence the expression of virus genes. Recently, however, alternatives to pathogen-derived resistance have been investigated. These include the use of geminivirusinducible toxic proteins to kill infected cells, and the expression of DNA binding proteins, peptide aptamers, AZF, G5 or GroEL homologues that either disrupt geminivirus infections or lessen their harmful effects. Mutation and recombination rates in geminiviruses could seriously undermine the durability of most currently available resistance transgenes. It should, however, be possible to achieve robust transgenic geminivirus resistance either by using mixtures of genes targeting multiple virus processes via multiple mechanisms, or by using "tolerance" genes that alleviate symptoms but do not selectively favor resistance-breaking virus mutants.

#### Chemical and Physical Characterization of Agar and Carrageenan Present in Red Seaweeds from Oman

#### Zainab Mohammed Said Salman Al Nahdi

Department of Food Science & Nutrition

Seaweed polysaccharides, like agar, alginates and carrageenans, are economically the most important products from algae. Although previously seaweeds were only used as gelling and thickening agents in food or pharmaceutical industries, recent researches have revealed their potential as complementary medicine. Furthermore, they are known also to contain bioactive products that display antibacterial, antiviral and antifungal properties. In fact, the discovery of metabolites with biological activities has increased significantly in the past three decades. On the other hand, seaweeds have recently received significant attention for their potential as natural antioxidants. Moreover, they are used for animal nutrition as feed or as fertilizers and soil conditioning agents. The estimated value of wide variety products that derived from the seaweeds is US\$ 5–6 billion.

The Sultanate stresses the need for a stable economy to enable the private sector to drive future growth, creating export-oriented industries and developing productive sectors such as agriculture and fisheries. Preliminary surveys conducted along the Sultanate's coasts revealed the presence of large biomass of different seaweed species along the southern region of the Arabian Sea coast of Oman. Thousands of seaweed grows annually where cold water rich in nutrients come to the surface as a result of the southwest monsoons. Nevertheless, this significant industrial natural resource is not participating in the Omani economic so far. The main objective of this study is to determine the commercial potential and utilization of different red seaweeds species that been collected from the south region of Oman (Mirbat and Sadah) by analysing their chemical and physical characterization of agar and carrageenan present in these seaweeds

#### **Integrated Pest Management in Greenhouse**

#### Qais Al Mawali

#### Department of Crop Sciences

Greenhouse crops are one of the most economic cash crops in Oman. Greenhouse crop production in Oman has increased substantially in the last 10 years. At the same time greenhouse crops are suffering from many different diseases such as Damping-off, Downy mildew, Powdery mildew, Root Knot Nematode and virus diseases. Chemical control is the first defense tool used to control most of these diseases, whereas cultural management is still very weak in used by farmers due to lack of knowledge. Intergraded pest management is the best way to reduce the stress of diseases and enhance production inside greenhouse. Good structure of greenhouse, double door, covering cooling pads with insect proof net, seedling trays, plastic mulch, using 5 double rows or 5 single rows instead of 6 double rows, good control of water and fertilizer, weed control, good crop browning and use of yellow sticky traps and good time of chemical applying showing excellent improvement in pest control with less chemical used.

#### Studies on Walnut (Juglansregia L): Antioxidant, Physicochemical Characteristic and Health Potential Against Experimental Parkinson's Disease

#### Reshmi Karingattil Vijayan, Mushtafa Mohd Essa, Samir Al-Adawi, Mohd Shafiur Rahman, Nejib Guizani

Department of Food Science & Nutrition

Parkinsons's disease (PD) is a neurodegenerative disease characterized by motor and non-motor symptoms and loss of dopaminergic neurons in substantantia nigra pars compacta. High oxygen demand and non-regenerative nature of neurons made oxidative stress a leading cause for the initiation and progression of PD.Walnut is a rich source of antioxidant polyphenols and polyunsaturated fatty acids such as a-linolenic acid and linoleic acid and walnut offers improvement in memory and functioning in Alzheimer' disease and aging mouse models was reported. But the studies of walnut against experimental PD were not done so far. So, the present study was aimed to assess the neuro-protective effect of methanolic extract of walnut against 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine (MPTP) induced neurotoxicity in SH-SY-5Y cell lines (in vitro) and C57BL/6 mice PD mouse models. The total flavonoids and polyphenols will be measured using various biochemical assays and qualitative analysis of polyphenols present in walnut will be done using HPLC/LC-MS/GC-MS. For cell culture study; MPTP (5 µM) will be administered to walnut (2-4 µg) pretreated SH-SY5Y cells. Cell viability, antioxidant status and oxidative stress related pathological events such as mitochondrial membrane potential and dysfunction and apoptosis will be assessed. For in vivo study MPTP (25mg/kg b.w in saline, s.c.) will be administered to walnut diet fed Adult Male C57BL/6 mice (25-30 g) for 35 days with a 3.5 day interval. Behavioral assessments and biochemical assessments will be done to detect symptomatic treatment potential of walnuts against experimental mouse. The antioxidant polyphenols present in walnuts may be able to exert neuroprotective effect against PD mouse model.

Poster Presentations *by* Faculty

#### Are Date Palms Going to Face a Devastating Disease in the Near Future?

#### Abdullah M. Al-Sadi<sup>1</sup>, Amna H. Al-Jabri<sup>2</sup>, Issa H. Al-Mahmooli<sup>1</sup>

<sup>1</sup>Department of Crop Sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University (SQU), Sultanate of Oman <sup>2</sup>Royal Gardens and Farms, Royal Court Affairs Sohar, Sultanate of Oman

Date palm is the most important crop in Oman and the Arabian Peninsula. Date palms are vulnerable to a number of disease problems. *Fusarium oxysporum* (Schlechtendahl) f.sp. *albedinis* (Killian & Maire)-induced bayoud disease is one of the most serious diseases of date palms. Despite its restricted distribution to a few countries, the disease has wiped out millions of date palm trees especially in Morocco and Algeria. *Ceratocystis radicicola* Bliss (anamorph *Thielaviopsis punctulata*) is also an important pathogen of date palm worldwide. It has a wide distribution in the Arabian Peninsula, Africa, Europe and the USA and causes a number of diseases in date palms which includes black scorch, root rot, trunk rot and wilt. Other diseases on date palm include balat disease, false smut, lethal yellowing and some other foliar and root diseases.

In Oman, little is known about date palm diseases and fungal pathogens which are threatening date palm production. Recent surveys indicated collapse of some date palm trees, with disease etiology being poorly understood. In addition, recent investigations have shown the association of over 20 pathogenic fungi with root diseases of date palms, with little information on threats imposed by these fungal pathogens on date palms. This study was therefore conducted to investigate fungal pathogens associated with root diseases of date palms in Oman and the potential for disease outbreak in future.

#### Characteristics and Antimicrobial Activity of Omani Frankincense

#### Ann Mothershaw<sup>1</sup>, Basil Nzeako<sup>2</sup>, Zahra Al Kharousi<sup>1</sup>, Safiah El Hadi<sup>1</sup>, and Shafiur Rahman<sup>1</sup>

<sup>1</sup>Department of Food Science and Nutrition, College of Agricultural and Marine Sciences, SQU, Sultanate of Oman <sup>2</sup>Department of Microbiology and Immunology, College of Medicine and Health Sciences, SQU, Sultanate of Oman

For millennia frankincense oleo-gumresin produced by *Boswellia sacra* trees has played a key role in the culture and trading of the Sultanate of Oman. As it is a natural product it is subject to considerable variation and is segregated into grades using traditional methods rather than scientific specifications. Different grades have become associated with different uses e.g. burning, chewing, and drinking, supporting the premise of varying characteristics. Although frankincense has a long history of beneficial use there are many aspects concerning its active components and mode of action that remain unclear, for example little is known about the smoke. As frankincense is the focus of many extensive research studies characterization of the product and consistency of batches is essential.

To follow a systematic research schedule with an overall objective of establishing a database of the physical and antimicrobial properties of Omani frankincense resin, oil and smoke.

This is the first detailed study of the physicochemical properties of *Boswellia sacra*. The characterized properties of Hojari and Sha'bi could provide some baseline characteristics of relevance to the grading and utilization of Omani frankincense. A quality index could be developed based on combining selected physical parameter.

Oil and smoke from the resin demonstrated antimicrobial activity, the level of which was dependent upon the microorganism and the amount of exposure. Identification of the inhibitory components could potentially highlight new applications for this renewable resource.

#### Arabian Sea is Getting Less Productive (?)

#### Sergey A. Piontkovski and Michel R. Claereboudt

Department of Marine Science and Fisheries College of Agricultural and Marine Sciences, SQU Sultanate of Oman

Goes *et al* (2005) reported an increase of the primary production of the Arabian Sea since 1997 (when sustainable satellite-derived time series of chlorophyll a became available) to 2004. By correlating sea surface temperature against satellite derived chlorophyll a for the summer season, they concluded that the escalating strength of sea surface winds is largely responsible for the increase in phytoplankton biomass in the western Arabian Sea, from 1997 to 2004. The authors underlined that the increase of productivity might have far-reaching consequences for the biogeochemical balance of the sea. Prakash and Ramesh (2007) tested the hypothesis of the productivity increase applicably to the eastern Arabian Sea, for the eight year period (1997-2005). The authors divided the eastern Arabian Sea into two large zones and found that remotely sensed chlorophyll a concentration has not changed significantly over the past 8 years, so the positive trend in chlorophyll reported for the western Arabian Sea was not observed in its eastern part. We were aimed at the revision of interannual changes of the chlorophyll a over entire area of the Arabian Sea.

To our mind, the region selected by Goes et al (2005) for the analysis (52-57°E, 5-10°N), was too small. The 5° square was located on the south-western edge of the Arabian Sea and had covered about 1% of its area. In our data analysis, the Arabian Sea was subdivided into 61 2-degrees squares covering all marine areas between 54 -76°E and 10-25°N. For each square, satellite derived (9-km spatial resolution SeaWIFS) Level-3 data for chlorophyll *a* concentration were used to retrieve monthly average time series (1997-2009). The temperature time series were extracted from the Hadley Center sea surface temperature dataset (Rayner et al. 2003). Data on wind speed were taken from the NCEP Reanalysis database (http://www.esrl.noaa.gov/psd/data).

The trend analysis revealed an overall warming of the whole Arabian Sea with most of the significant slope values located in the central part and eastern margin. Overall, the analysis based on the Mann-Kendall test has enabled us to treat the Arabian Sea as a balanced system exhibiting pronounced physicalbiological oscillations with typical periods of 12 and 6 months (which reflected the seasonality of monsoonal winds), with no rising trends of chlorophyll *a*, on the time scale of the past 12 years (1997-2009). This means that the sea did not get more productive, so far.

#### Regime Shifts in Sea Surface Temperature and its impact on the Climate and Marine Environment of Oman

#### Y.V.B. Sarma and Anesh Govender

Department of Marine Science and Fisheries College of Agricultural and Marine Sciences, SQU Sultanate of Oman

Regime shifts in the sea surface temperature (SST) and associated environmental parameters such as rainfall and sea surface height were investigated using a 50 year (1961-2010) record of SST off Muscat and off Masirah along Oman. Transition from quasi-steady state appears to have occurred recently both in SST and climatic events over Oman. Regime shifts in SST occurred several times on shorter time scales prior to 1984 but a notable shift in SST occurred after 1984 when the mean annual SST increased by 0.53°C off Masirah and by 0.32°C off Muscat. A generalized additive model was developed and successfully simulated the bimodal variability of the SST at the selected locations. An increase in summer warming coupled with decrease in winter cooling rendered the upper ocean warmer after 1984, a condition that is counter-productive. Anomalous increase in SST during the month of May (by about 2°C) in the study region was observed before the severe cyclones "Gonu" in 2007 and "Phet" in 2009 hit the Oman coast. Seasonal amplitude and period of heating/cooling are smaller and shorter off Muscat compared to Masirah. The sea surface height (SSH) anomalies from altimetry showed that variability in sea level is higher during post-1990 period. The regime shift in the SST coupled with SSH changes apparently caused massive and protracted periods of harmful algal blooms (HABs) during recent years. The correlations among the mean annual SST, rainfall and the multivariate ENSO Index (MEI) show that the influence of El Nino-Southern Oscillation (ENSO) is evident on the SST regimes and rainfall variability off Muscat and Masirah.
# Some Significant Research Completed in 2012

# Some Significant Research Completed in 2012

#### Research Theme: Environmental and Biological Research (EBR)

## Title: Characterization, Evaluation and Conservation of Indigenous Animal Genetic Resources in the Sultanate of Oman (SR/AGR/ANVS/08/01)

#### **Research Team:**

Osman Mahgoub<sup>1</sup>, PI Isam Tawfil Kadim<sup>1</sup>, Co-PI Waleed Saeed Al-Marzooqi<sup>1</sup>, Co-I Yasmin Elhag Eltahir<sup>1</sup>, Co-I Mohamed Ali Al-Abri<sup>1</sup>, Co-I Hamza Ali Babiker<sup>2</sup>, Co-I Eid Salim Al-Shukeili<sup>3</sup>, Co-I Mushtaq A. Memon<sup>4</sup>, Consultant Albano Beja Pereira<sup>5</sup> Consultant Aisha Al-Khayat Al-Shihi<sup>6</sup>, Co-I Rashid Saud Al-Habsi<sup>3</sup>, Co-I Musab Hilal Al-Busaidi<sup>1</sup>, Technician Kaadia Khalaf Al-Kharousi<sup>1</sup>, Technician Sadeq Mohamed Al-Lawati<sup>1</sup>, Technician Samera Q. Khalaf<sup>1</sup>, Technician

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The project aimed at examining the genetic makeup of indigenous Omani livestock breeds using molecular markers to provide information on genetic variation within native cattle, sheep and chicken. The project also aimed at testing the reproductive efficiency of Omani male animals. In addition, the project envisaged training of Omani personnel, including biomedical scientists, undergraduate and postgraduate students as well as establishment of molecular genetic facilities in the college of Agriculture and Marine Sciences and at SQU.

The genetic analysis used in the project was based on state-of-the-art approach for genotyping of microsatellites, which is the most informative and powerful genetic markers for both linkage analysis and population based studies. Microsatellites analysis was carried out on cattle, goats and chicken of local breeds from different regions of Oman. For goats, a total of 202 samples from five native Omani breeds (Batina, Musandam, Dhofari, Al Jabal Al Akhdar and Sharqiyah.) and two commercial goats (Iranian and Somali goat breed) were analyzed. Blood sample were collected and the genomic DNA for these animals was extracted. PCR amplified with 10 microsatellite markers. In addition, we collected 100 samples of Omani cattle, 36 of these samples were genotyped using 11 microsatellites and compared with Libyan, Indian and Portuguese cattle to throw light on the origin of Omani cattle. Similarly, we analyzed samples from 158 Omani native chickens from six Agro-ecological zones: Batina, Dhofar, North Hajar, East Hajar, Musandam, and East Coast. Following DNA extraction, electrophoregram processing and allele-size scoring was performed with the RFLP SCAN software package (Scanalytics). Microsatellite toolkit was used to estimate total number of alleles, allele frequencies, and average number of alleles per locus.

Breeding Soundness Examination (BSE) was carried out on Omani native bulls and bucks to test their breeding efficiency utilizing established international standards. Each animal was examined for body condition score, musculoskeletal problems, and overall physical condition. Testes and epididymides were tested and accessory glands of the bulls were examined per rectum. Semen from bulls and bucks was collected with electroejculator and was evaluated for sperm mass activity, motility, concentration and sperm morphology using standard methods.

The project investigated the possibility of long-term cryo-preservation of semen collected from male bucks and bulls. Semen samples were evaluated then stored frozen in liquid nitrogen for future genetic studies and for artificial insemination of females

A high degree of genetic diversity was observed among Omani goats. The observed number of alleles for unlinked 10 microsatellite locus ranged from 36 (OarFCB020) to 96 (HSC) across seven breeds. The mean number of alleles of Omani breeds was 9.02 with a range between 7.7 (Batina and Sharqiyah goat) and 11.6 (Musandam goat) whereas the mean number was found in Iranian and Somali breeds were lower than Omani goat breeds 8 and 6.6 respectively. Genetic distance was least (0.130) between Sharqiyah and Jabal Akhdar and highest between Jabal Akhdar and Somali breeds (0.478). In the cattle study, all loci were polymorphic and the number of alleles per loci varied between 8 and 17 with no considerable differences between breeds expected heterozygosities. The analyses of molecular variance (AMOVA) showed that 80% of the variation occurs within populations and only 20% of dataset variance is justified by differences among populations. The PCo admixture analysis revealed that Omani cattle is a mixture of Indian zebu with African and Near East taurine cattle with Indian zebu cattle playing a key role in the genesis of the Omani local breed.

The study on Omani chicken revealed a total of 217 alleles observed across all populations. The average number of alleles per locus was  $5.3\pm2.43$ . The mean number of alleles reflected high level of genetic variability in the investigated populations. The overall expected heterozygosity was  $0.62\pm0.03$ while the observed heterozygosity was  $0.54\pm0.02$ . The overall value of Fis was  $0.130\pm0.024$  with a range of 0.193 (Dhofar) and 0.056 (North Hajar). The largest Nei's unbiased genetic distance was found between the Batina and Dhofari populations and the smallest between the Batina and North Hajar populations. The Dhofari population was found to be the most genetically distant among all populations studied.

Native Omani breeding bulls and bucks BSE parameters (scrotal circumference, semen mass activity, sperm morphology, etc.) were established and compared to Zebu/Zebu-cross bulls; and bucks in the tropics. The mean volume of semen and the sperm concentration obtained by electro ejaculation in Omani bulls was  $9\pm1$  ml (range of 5 to 14 ml) and  $285\pm25$  million/ml, respectively. There was no significant variation during the present study between the extenders as far as post thaw evaluation of the percent intact acrosome, percentage of spermatozoa that reacted to HOST and sperm abnormalities.

Semen samples were successfully collected and evaluated from Omani bulls and bucks then stored in liquid nitrogen in straws. These samples will be regularly tested to study the effect of long storage on semen quality. They may be used for breeding Omani native cows and does using AI in the future. This part of the project would provide optimum methods for genetic material conservation to assist conserving national animal bioresources for future use in future genetic improvement programs. Omani personnel has been trained using workshops and in the University of Porto, Portugal.

In conclusion, the Omani populations of goats, cattle and chicken were found to have high level of genetic diversity. The genetic diversity observed in Omani cattle is an indicative of gene flow from other regions that perhaps still is ongoing with the Indian zebu cattle played a major role in the genesis of the Omani population. Breeding soundness of Omani male goats and cattle has been tested and semen was successfully preserved in liquid nitrogen ready for breeding females. The conservation strategies of these local breed should be considered in near future. These results can be used to establish national conservation and breed improvement strategies for economic traits. Omani technical staff and postgraduate students have been trained within the project.

### Research Theme: Environmental and Biological Research (EBR)

## Title: Rejuvenating Lime Production in Oman: Resolving Current Challenges (SR/AGR/CROP/08/01)

#### **Research Team:**

Rashid Al-Yahyai <sup>1</sup> , PI	Malik Al-Wardi <sup>2</sup> , Co-I
Fahad Al-Said <sup>1</sup> , Co-PI	Abdullah Al-Zidjali <sup>3</sup> , Co-I
Michael Deadman <sup>1</sup> , Co-I	Ali Al-Lawati <sup>3</sup> , Co-I
Abdullah Al-Sadi <sup>1</sup> , Co-I	Abdullah Al-Zidjali <sup>3</sup> , Co-I
Ali Al-Wahaibi <sup>1</sup> , Co-I	AbdulRahman Al-Matrooshi <sup>3</sup> , Co-I
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#### Affiliation:

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This research aimed at providing short-term integrated management strategies for sustainable production from lime trees infected with Witches' Broom Disease of Lime (WBDL) associated with *Candidatus* Phytoplasma aurantifolia. Another objective is the development of long-term solutions through detailed investigation of the causal agent, victors, and hosts of WBDL. Furthermore, the project aimed at investigating the major biotic and abiotic factors that influence infection and spread of the WBDL. The project ultimately provided information that is critical for continued production from infected trees while long-term resistance is sought.

The project implementation was divided into several sub-projects that investigated the followings: A field survey to determine the extent of the spread of the disease throughout Oman, the biological diversity of lime trees, and the associated diseases to WBDL; molecular analysis of the collected samples using Polymerase Chain Reaction (PCR) techniques; entomological studies of the disease vectors and hosts in selected regions of Oman; physiological studies using infra-red gas exchange measurements; soil and water status as determined by capacitance probes; yield and fruit quality of infected trees using standard fruit quality analytical methods; and tree phenological cycles by associating tree phenological cycles observed visually with weather data.

Survey of limes was conducted in all Governorates of Oman and found that WBDL incidence was found in 97% of the farms visited including new areas

in Al-Wusta and Dhofar. The survey also found that old non-symptomatic trees were found in limited numbers, indicating potential for disease resistance. A serious viral disease called Citrus Tresteza Virus (CTV) was detected in over 85% of the surveyed wilayats. A moderate to high levels of infection with CTV in lime were detected in the Northern part of Oman (15-47% compared to the South (0-12%). CTV was found to be introduced into Oman via infected citrus seedlings imported from Syria, Lebanon, India, Pakistan and Egypt, where 45% of the seedlings were found to be infected with the virus. CTV was detected for the first time in sweet lime, sweet lemon, citron, mandarin and sweet orange in Oman. Low genetic diversity of Omani lime with similarity index of > 95% indicated that Omani limes are genetically identical thus little resistance to WBDL was present. Furthermore, gene flow indicated that limes were exchanged among farms which may have helped spread the diseases in new regions. Asymptomatic limes that are infected with the disease were biochemically different from symptomatic with high percentages of Citral (45%), Limonene (7%), and Cineole (7%), that may play a role in the development of the symptoms in infected trees. However, little variations in physiological indicators were detected among the lime trees. Results from infected trees showed that an economical yield and good fruit quality can be obtained from WBDL-infected lime trees. PCR analysis of periwinkle (Vinca rosa) grown in Oman as an ornamental plants with symptoms of stunted growth, yellowing and little leaf showed that periwinkle is infected with phytoplasma. This phytoplasma is identical to the one infecting lime trees and can be transmitted by a seed thus contributing to the spread of Withces' Broom disease. Forty two morphospecies of hoppers (leafhoppers, planthoppers, and pysllids), were found on lime/citrus and other host plants at SQU Agricultural Experimental Station in AlKhodh, Muscat Gov. Two species (Hishimonus phycitus, Diaphorina citri) were commonly found on citrus. Hishimonus phycitus, the hopper species most suspected as a vector of WBDL was collected also from different sites in Musandam (Daba and Madha), Al-Jabal Al-Akhdhar, and Salalah. Yield and fruit quality of Omani lime is superior to that of imported lime and that fruiting can extend beyond ten years when proper cultural management is implemented in lime orchards.

Results from this project indicated that lime biodiversity is low, thus further work on enhancing the genetic base of Omani lime is needed. This can be achieved by introduction of resistant citrus cultivars for field evaluation. Limit the spread of the disease by limiting the distribution of infected materials is important and the eradication of alternative hosts, such as *Vinca rosa* is vital. Immediate actions to limit the spread of CTV are urgently needed and the introduction of resistant rootstocks that are adapted to the Oman's edaphic and climatic conditions. Mechanism of disease transmission and the role of infected seeds and the insect vectors need further investigation. Practices such as irrigation, fertilizer and nutrient management, and pruning of symptomatic shoots are essential for prolonged production of economic yield and good quality fruit from infected trees.

#### Research Theme: Environmental and Biological Research (EBR)

### Title: Heavy Metal Contamination in Fish and Shellfish (CL/SQU/IIUM/09/01)

#### **Research Team:**

Stephen J. Goddard, PI Said Mohammed Al-Barwani, Co-PI

#### Affiliation:

Department of Marine Science and Fisheries, College of Agricultural and Marine Sciences, SQU, Oman

This was a collaborative project between Sultan Qaboos University (SQU) and the International Islamic University of Malaysia (IIUM). It was jointly funded by the two institutions. The main goals for the project were firstly to develop analytical procedures at SQU for the determination of trace metal contamination in sediment and living tissues in accordance with international standards and secondly to establish collaborative research with IIUM, including the exchange of scientific expertise, researchers and graduate students.

Early attempts to gather representative samples of fish tissues were unsuccessful and the field collections in Oman focused on the heavy metal content in the rock oyster (*Saccostrea canniculata*). In Malaysia the study was extended to other bivalve molluscs including the razor clam (*Solen brevis*) and the blood cockle (*Anadar granosa*). These are commercial species, which are commonly used as biomonitors for heavy metals in the marine environment.

The results from Oman revealed clear evidence of accumulation of aluminium, cadmium, copper, iron and zinc in rock oysters. Of particular interest were the high levels of cadmium (6.9-51.6 ppm). These have also been reported from previous studies. The highest levels of cadmium were recorded in Sadah, Salalah. This may reflect strong offshore upwelling during the SW monsoon, which is known to bring deep cadmium-rich water to the surface. Although likely of natural origin, the values recorded were well in excess international food safety guidelines (USA 4ppm; EU 2-5ppm) for cadmium in oysters. Of particular concern, the highest cadmium levels in this study were recorded from Salalah, the main harvesting area.

All of the original objectives for this project were met and successful collaborative research was established with the Institute of Oceanography and Studies at IIUM. Over the course of the 3-year project 5 joint papers were published in peer-reviewed journals and two papers were given at international meetings. Plans are currently being discussed to extend marine science research collaborations between SQU and IIUM.

# Summary of Internal Grant Projects Awarded in 2012

### Identification of Camel Meat Quality Parameters Using Proteomics

#### Isam Kadim, P.I.

**Duration:** 3 years

**Budget (RO):** 10,250

The demand for camel meat appears to be increasing due to health reasons, as they produce meat with relatively less fat than other animals. However, camel meat has been associated with low quality attributes because it comes mostly from old camels, which were primarily kept for racing, milk and transportation rather than meat. Proteomic technology is a powerful tool to identify proteins that reflect the important mechanisms and contributions to development of a satisfactory meat quality. An optimized protocol for camel meat protein extraction that provides sufficient amounts of relatively pure proteins will be developed. The proposed project aims to analyze the proteome of camel muscle tissue collected immediately after slaughter, and search for individual proteins that correlate with meat tenderness and juiciness. Identification of such proteins could help predict the tenderness and juiciness of camel meat at a time that decisions in the slaughterhouse can be made, i.e. during the time period between killing of the animal and chilling of the carcass. A more general aim was the assessment of proteomics as a method for the identification of marker proteins that can predict meat quality. A combination of two-dimensional electrophoresis and mass spectrometry will be used to study metabolic alterations of various proteins in one-humped camel six muscles (infraspinatus, triceps brachii, longissimus thoraces, biceps femoris, semitendinosus, and semimembranosus).

#### Utilisation of Prosopis juliflora for Feeding Omani Livestock

#### Osman M. Gaafar, P.I.

**Duration:** 3 years

#### **Budget (RO):** 8,850

Prosopis juliflora was introduced to Oman in the 1970s to combat desertification and for urban beautification. Soon it became a pest and spread over large areas of the country and today is Oman's worst invasive species. It had the ability to become established at the expense of local species in both irrigated and range lands. There were serious attempts to eradicate the trees, especially on the Salalah plain, but like elsewhere in the world this was largely unsuccessful. Therefore, this study proposes to investigate both the distribution of the tree and its potential use for livestock feeding. It also aims at processing the Prosopis pods and leaves and incorporating them in livestock rations. Chemical composition of the tree pods will be evaluated by determining proximate composition as well as carbohydrates, minerals, vitamins and other components (tannins, sabonins, etc.) in the seeds, pods and leaves. Prosopis pods will be subjected to various processes including soaking in water to remove bitter taste, crushing and grinding. Prosopis pods will be collected during fruiting season and used as a plant protein and energy source. They will be subjected to chemical analyses and various in vitro and in vivo investigations to determine their nutritive value before incorporation into rations of native sheep and goats at various levels. Feed intake will be measured and effects of feeding of these rations on growth, carcass composition and meat quality will be evaluated. In vitro studies will include determination of anti-nutritional effects of elements such as tannin. In vivo studies will include determination of digestibility of feeds and feeding trials will be conducted to evaluate feed intake, body weight growth, and carcass composition and quality. The outcome of this project would help to find alternative protein and energy sources to be used as animal feeds to reduce production cost and increase local farmer's revenue. Various tasks will be carried out by the staff of the Department of Animal & Veterinary Sciences, and Agricultural Experiment Station, College of Agriculture, Sultan Qaboos University. As the Prosopis been recently regarded as a pest threatening local biodiversity, especially in the Governorate of Dhofar where it threatens the unique monsoon woodlands, other concerned bodies around the country are interested to investigate the use of this species for animal feed. Therefore, the project will include collaboration with the Diwan of Royal Court and the Ministry of Environment and Climate Affairs.

### Influence of Crop Duration and Grafting On Crop Productivity and Quality in Greenhouse Cucumber

### Fahad AlJulanda Al-Said, P.I.

**Duration:** 3 years

**Budget (RO):** 8,850

There is a significant interest in growing cucumbers in greenhouses world wide. In Oman, cucumber is produced in green houses, with over 95% of the national greenhouses are used for cucumber production. Cucumber production in Oman is limited by a number of constraints, for example: short growing season, increasing salinity in irrigation water and soil borne diseases. Consequently such malodies do not only reduce crop yield but also shorten the supply period and lessen return to growers. The problem of extension in growth period can be addressed by manipulating cucumber crop husbandry and grafting onto desirable rootstocks. In general cucumber is grown up to twelve weeks in the greenhouse, thus only 3-4 successive crops can be achieved in the Omani environment. Studies on shortening harvest time in cucumber through crop management and rootstock effects are rare. However, it was observed that maximum cucumber production curve was obtained during 10-12 week of crop harvest. By gaining time through early harvest at week ten, one further crop cycle can be achieved during summer time. Feasibility will be worked out to test the hypothesis of growing more crop cycles through rootstock intervention and reducing final harvest time. This will also facilitate an enhanced supply period, increased yield and income through high intensity planting and appropriate rootstock exploitation.

#### **Bioactive Compounds from Oman Marine Organisms**

#### Sergey Dobretsov, P.I.

**Duration:** 3 years

**Budget (RO):** 10,250

Marine organisms are a rich source of new bioactive molecules that exhibit anti-microbial, anti-viral, anti-tumour, anti-inflammatory, and anti-fouling properties. These compounds might have applications in medicine, biotechnology and industry. Only few bioactive compounds have been isolated from marine organisms inhabiting the Arabian Gulf and Sea of Oman. In this investigation we plan to screen Oman marine organisms for anti-microbial, anti-quorum sensing and anti-tumour activities. Mainly, we are going to focus on isolation of bioactive compounds from marine microorganisms, fungi and soft corals. These organisms have been selected because of their high biotechnological potential and existence of chemical extracts as well as bacterial and fungal cultures obtained by the PI and co-investigators during previous projects. Anti-bacterial, anti-fungal, anti-quorum sensing and antitumour compounds will be purified using a bioassay guided fractionation. Identification and structure elucidation of bioactive compounds will be done in cooperation with the scientists from Germany and USA. Additionally, the mode of action for some bioactive compounds will be determined. Throughout the project, emphasis will be placed on capacity building especially through the training of young Omani scientists. Education benefits will occur through scientific publications in peer review journals and knowledge transfer. The proposed research will enable us to explore the marine resources in Oman, train SQU students and discover novel anti-microbial, anti-quorum sensing and anti-tumour compounds from Oman marine organisms that can be used in aquaculture, agriculture, and medicine.

## Feasibility of Soft-coral and Sea-cucumber Identification Using Fluid Particle Imaging and Automated Shape Analysis

#### Michel R. Claereboudt, P.I.

**Duration:** 3 years

**Budget (RO):** 9,000

In several groups of marine invertebrates, individual species are notoriously difficult to identify because their taxonomy is based on the morphology, size and relative abundances of minute skeletal sclerites. In particular the Holothuroidea (Sea Cucumbers) and in Alcyonaria (Soft Corals), abundant in the coastal waters of Oman form an important part of the benthic communities and belong to this category.

The aim of this study is to evaluate the potential of automated image analysis of skeletal sclerites for the purpose of species identification. Several species of sea cucumbers and soft corals will be identified using traditional methods and using a combination of fluid particle image acquisition (hardware) and particle shape analysis (software). This could provide the basis for an expert system designed to identify these groups of organisms and facilitate the work of taxonomists but also of environmental managers and environmental assessors (users of taxonomy).

## Evaluation of the Effect of Soil Compaction and Tillage Management on the Growth and Yield of Crops

#### Hemanatha Jayasuriya, P.I.

**Duration:** 3 years

**Budget (RO):** 8,550

The machinery use for land preparation and other crop maintenance activities may have both positive and negative effects unless used in proper way. Excess traffic of machinery on agricultural fields can cause significant reduction of yield and productivities due to soil compaction. Due to limited arable lands and cultivable time, meaningful mechanization has significant role in Omani agriculture. As per the percent trend, most small farmers use machinery for farming activities in order to achieve timeliness and to overcome the scarcity of labour. Improper use of machinery, particularly heavy machinery while conducting irrigation applications can make this problem worst by magnifying the soil consolidation effect and compaction. These conditions can be accumulated for years unknown to farmer, resulting low yields and productivities.

Proper understanding or machinery use management, selection of proper sizes matching with soil conditions, and use of controlled-traffic approach can minimize the soil compaction effect of crop production. This research intended investigating the current status of compaction due to machinery use in farming activities. Experiments will be conducted in the premises of Agricultural Experimental Station (AES) at Sultan Qaboos University (SQU), in the farm fields. GIS techniques will be used for the farm field plots, in which the layer-based GIS maps will be created for multiple seasons of crop cultivation. Soil compaction effect will be simulated by planned machinery traffic in field strips with randomized block design manner in order to model and evaluate the effect. It is intended to develop recommendations and guidelines for machinery use and tillage management for the selected crops, soil types and conditions leading to better crop productivities.

# **Computer Simulation Model for Improving Wheat Production**

#### Yaseen Al-Mulla, P.I.

**Duration:** 3 years

**Budget (RO):** 10,250

Computer simulation model for improving wheat production through predicting the time and percentage of wheat emergence based on planting depth, soil temperature, and soil water potential will be evaluated and validated at different locations. By which the developed model can be promoted as a tool of improving the wheat cultivation and increasing the growing acreage of wheat in the Sultanate.

# Research by Graduate Students

# Abstracts of Research Proposals - 2012 PhD Students

Chemical and Physical Characterization of Agar and Carrageenan Present in Omani Red Seaweeds

Student Name	:	Zainab Mohammed Said Salman Al Nahdi
Supervisor	:	Dr. Ahmed Al-Alawi
Department	:	Food Science and Nutrition

Seaweed polysaccharides, like agar, alginates and carrageenans, are economically the most important products from algae. Although seaweeds are traditionally used as gelling and thickening agents in food or pharmaceutical industries, they are also used as livestock feed, fertilizers, and recently as a potential source of biofuel. The seaweed industry provides a wide variety of products that have an estimated total annual value of US\$ 5.5-6 billion.

The quality of phycocolloids or the seaweeds extracts is affected by different factors. These factors includes species, location (environmental factors related to the alga growth, light, nutrients, and temperature, etc.), and extraction procedure. In this context, the extraction procedure is used to enhance gel properties by adapting the treatments to each species. In particular, variables like alkali concentration, temperature and time duration must be adjusted to obtain as much desulphation as possible, which will increase the gel strength, while still avoiding yield losses that this process can cause.

Previous surveys conducted along the Sultanate's coasts revealed the presence of huge quantities of different seaweed species along the southern region of the Arabian Sea coast of Oman. Thousands of seaweed grows annually where cold water rich in nutrients come to the surface as a result of the southwest monsoons. Nevertheless, this significant industrial natural resource is not participating in the Omani economic so far.

The main objective of this study is to determine the commercial potential and utilization of two different red seaweeds species (*Melanothamnus somalensis*, and *Hypnea bryoides*) that grow in the southern region of Oman (Mirbat) to produce two phycocolloids (agar and carrageenan). The quality of the phycocolloids will be assessed by analyzing the chemical, thermal and physical characteristics of the yield which will be extracted at different conditions/parameters.

# Potential of Near-infrared and Color Imaging to Detect Microbial and Fecal Contamination in Omani Dates

Student Name	:	Teena Ann Mathew
Supervisor	:	Dr. Manickavasan Annamalai
Department	:	Soils, Water & Agricultural Engineering

Date fruits are contaminated by various fungal species, thus causing their spoilage during storage and processing stages. Detection of fungal infection in dried edible dates is significant because of the production of mycotoxins which can cause severe food poisoning. Routine laboratory analyses for microbial spoilage in dates is time consuming and expensive. Rapid, accurate, non-destructive computer vision techniques have been applied to detect microbial spoilage in cereal grains, nuts, fruits, vegetables, meat and so on. The potential of near-infrared imaging and visible color imaging to detect Aspergillus flavus and aflatoxin contamination on edible dates are investigated here. Dried date palm fruits (fard and khalas variety) are collected asceptically from factories, shops and local market. The dates are artificially inoculated with Aspergillus flavus and incubated until surface growth appears. Images of such dates are captured, processed and classified. The mold growth on the date surface is then cleaned and analyzed for the presence of aflatoxin by image processing and also confirmed by chemical analyses. Fecal contamination of readily eaten fruits and vegetables is an important source of pathogenic microorganisms such as E. coli. Date fruits may be contaminated with fecal contaminants during harvesting, drying or even storage period. Poultry feces are smeared as spots of variable sizes on date surface and detected using image processing.

# Management of whitefly transmitted begomovirus associated with tomato (Lycopersicon esculentum Mill) in Oman

Student Name	:	Aadel Al-Shihi
Supervisor	:	Dr. Akhtar Jamal Khan
Department	:	Crop Sciences

Tomato yellow leaf curl virus (TYLCV) is a whitefly-transmitted begomovirus. During field survey in 2010-2011 disease incidence on tomato associated with begomovirus was found to be 10-100%. Disease symptoms, which include yellowing, leaf curling and severe plant stunting are reminiscent of begomovirus. Tomato seedlings covered with Agryl net in nursery and 6-7 weeks after transplant showed less than 5% viral symptoms and high tomato yield. In transmission studies, female whiteflies were found more efficient in transmitting virus and associated satellite DNA as compared to male whiteflies. Viral acquisition and transmission rates by whitefly were evaluated by symptoms development and confirmed by PCR. The minimum acquisition period was found to be 30 min and transmission period 15 min for successful disease development. Seventeen tomato breeding lines introgresed with Ty genes resistant to begomovirus, were challenged with viruliferous whiteflies. Nine out of seventeen breeding lines showed no symptoms and were field resistant, whereas eight breeding lines showed moderate to high susceptibility to TYLCV. Amplification fragment length polymorphism (AFLP) revealed a high polymorphism among all breeding lines. Most of the resistant breeding lines clustered together but some with susceptivle ones indicating that clustering is due to their genetic relatedness and not the resistance. This can contribute to make some decisions by breeders in relation to the choice of the appropriate parents and linkage for the resistance genes.

# Thesis Abstracts of Postgraduate Students who Graduated in 2012

# <u>MSc</u>

# A Study on the Binding of *Brucella* Protein, BP26, to Select Extracellular Matrix Molecules

Student Name	:	Amna Salim Al-Araimi
Supervisor	:	Dr. Yasmin El Tahir Ahmed
Department	:	Animal and Veterinary Sciences

*Brucella* an intracellular bacterial pathogen is the causative agent of brucellosis. It is a disease affecting wide spectrum of animals and Man. *Brucella* proliferates within several types of phagocytic and non-phagocytic cells. An essential step utilized by bacteria to colonizing a host involves adhesion to a variety of tissues. In many bacterial-host interactions, adherence is mediated by one or more adhesins that can act simultaneously or in distinct steps of an infectious process; however, little is known about the molecular basis of *Brucella* adherence to host cells.

The present study focused on BP26, a *Brucella* protein that is conserved among all *Brucella* species. The ability of BP26 protein to bind extracellular matrix molecules was determined by Enzyme-Linked Immunosorbent Assay (ELISA) using immobilized and soluble type I collagen, vitronectin, fibronectin and laminin. In the present study it has been demonstrated that BP26 bound in a dose-dependent manner to both immobilized and soluble type I collagen and vitronectin. BP26 bound in a concentration dependent manner to soluble but not immobilized fibronectin. Interestingly, BP26 not bound to laminin in any form.

Epitope mapping using overlapping 15-mer synthetic BP26 peptides, anti BP26 MAb, collagen and vitronectin led to the identification of four linear antigenic regions on BP26, ranging from residues (51-65), (96-110), (121-135) and (226-250). Vitronectin recognized additional regions ranging from residues (146-160) and (176-190). Conclusively, the strongest antigenic region on BP26 resides on the C-terminus. Interestingly, BP26 peptides did not bind to fibronectin, indicating that the fibronectin-binding site of BP26 is conformational.

Our results highlight the role of BP26 protein in the binding of *Brucella* to the extracellular matrix molecules *in vitro*, which may result in the attachment and spreading of the organism within the host. These are novel findings that offer new insight into understanding the interplay between *Brucella* and host target cells.

# Molecular Characterization of Chili Leaf Curl Virus and Satellite DNA Associated with Peppers in Sultanate of Oman

Student Name	:	Amal Muslem Ismail Al-Zaidi
Supervisor	:	Dr. Akhtar Jamal Khan
Department	:	Crop Sciences

Pepper (Capsicum annum) is cultivated in Al-Batinah, Al-Sharqiya and Dhofar regions in the Sultanate of Oman during the winter season to meet the high demand for fresh produce in the domestic market. To identify the causal agent of a widespread disease associated with infestations of the whitefly Bemisia tabaci (Genn.), leaves were collected from hot pepper and sweet pepper plants showing symptoms characteristic of the begomovirus disease in southern and northern regions of Oman during 2010 and 2011. Typical symptoms of chili leaf curl disease were observed on infected pepper plants that includes shortening of stem internodes, interveinal yellowing, upward curling of the leaf blade, downward rolling of the leaf blade, reduction of the leaflet area, fruit discoloration and fruit size reduction. The disease incidence varied from farm to farm ranging 0-100% irrespective of geographic locations but depending on farmer's management practice. In general pepper seedlings protected from whiteflies in nursery and for few weeks post transplanting showed little or no begomoviral symptoms. On the contrary seedlings infested with whiteflies in nursery and field exhibited severe symptoms with disease incidence of 80-100%. Total nucleic acids were isolated from the symptomatic pepper leaves and used as the template for polymerase chain reaction (PCR) to confirm the presence of begomovirus. Seventeen out of 34 symptomatic samples were tested positive with begomoviral specific PCR primers. Subsequently, nucleic acid from PCR positive symptomatic samples was used for  $\varphi 29$  DNA polymerase amplification of begomoviral circular DNA. Putative full unit length begomoviral DNA multimers were digested with Xbal and cloned into the plasmid vector pUC19. The complete nucleotide (nt) sequence was determined as 2758 base pairs (bp), indicative of a monopartite begomoviral genome. A comparison of the genome sequences of twelve field isolates indicated that they shared 97 - 100% nt identity. The virus from Oman was found to be most closely related to Chili leaf curl virus-Multan (ChLCV-Multan) sharing >91% nt identity, a monopartite begomoviral isolate described previously from Pakistan. A satellite DNA (DNA  $\beta$ ) was amplified by PCR using begomovirus beta satellite specific degenerate primers. Fulllength satellite DNAs were cloned and their DNA sequence were determined. Beta satellite were found to have circular ssDNA genome with single ORF  $(\beta C1)$  know to function as pathogenicity determinant. Analysis of the complete nt sequence of 1327 bp indicated that the DNA  $\beta$  shared 95% nucleotide similarity with its closest relatives, Tomato yellow leaf curl betasatellite-Al-Batinah isolated from tomato in Oman. The genome organization of all isolates of Chili leaf curl virus from Oman was similar to those of other monopartite begomoviruses. All ChLCV isolates showed circular, ssDNA genome with six ORFs (V1, V2, C1, C2, C3, C4) of which two were arranged in virion sense and four in complimentary sense. The amino acid sequence analysis revealed that V1 and V2 ORFs have highest similarity with PepLCV-Lahore and ChLCV-Lahore, respectively and C1-C4 ORFs showed highest similarity with ChLCV-Multan indicating the presence of recombination. Using the RDP3 recombination detection program, a recombination event involving Pepper leaf curl virus-Lahore as a minor parent, and Chili leaf curl virus-Multan and Papaya leaf curl virus-India as major parents were detected in ChLCV-OM sequence. Infectious clone consist of the partial tandem repeat of the viral genome were constructed in the binary vector pCAMBIA-1301 and agroinoculated to Nicotiana benthamiana. The viral clone produced severe upward leaf curl of the small, newly emerged leaves and vein thickening compared to controls.

# Morphological and Molecular Characterization of Faba Bean (Vicia Faba) Accessions in Oman

Student Name	:	Aisha Ali Suleiman Said Al-Farsi
Supervisor	:	Dr. Nadiya Abubakar Al-Saady
Department	:	Crop Sciences

This study was conducted to characterize faba bean landraces, which is locally grown in Oman by using morphological and molecular markers. Since the variations in local faba bean still are not exploited and no description of the variation of this species is available. Twenty-five local faba bean accessions were studied in Sultan Qaboos University (SQU). The morphological study was carried out in the glass house of Agriculture Experiment Station at SQU, with optimum temperatures ranging from 22°C to 25°C. These accessions were from three regions of Oman; Dhakhilia, Batinah and Dhahira. The growth of random faba beans plants (thee plants/ accession) were observed and evaluated. The measurement was taken according to IBPGR Faba bean descriptors (1985) for eleven qualitative and ten quantitative traits. Amplified Fragment Length Polymorphism technique was applied on the same faba bean accessions used for the morphological analyses. In addition, 10 international accessions from four countries; India, Pakistan, Yemen and Iran from the ICARDA collections were used in the study. The morphological study illustrated high levels of diversity of both quantitative and qualitative characteristics. Shannon's weaver index for qualitative traits averaged 0.73 and for quantitative traits the overall average was 0.72. On the other hand, AFLP methodology was successfully employed in this study for detection of molecular variation in faba bean landraces. Analysis of the 35 accessions using six EcoR1/Mse1 primer combinations generated amplification of 2435 total scorable band with the average of 405 bands per primer pair ranging from 344 to 475. The total percentage of polymorphism was from 95.84% to 98.11% with an average of 97.29%. A significant level of variation was detected in the overall level of diversity (Shannon's information index) on primer pairs ranging between 0.1509 and 0.2129. AMOVA analysis showed that genetic variance within faba bean accessions reached to 93.39%.

Overall, the results of both these methods (morphological and AFLP) successfully confirmed that the faba beans accessions are a highly varied and clustered without any definite pattern with regard to geographical origins.

# Phenotypic and Genetic Diversity of Omani Cowpea (Vigna unguiculata, (L.) Walp.) Accessions

Student Name	:	Safa Mohammed Hamed Al-Hinaai
Supervisor	:	Dr. Nadiya Abubakar Al-Saady
Department	:	Crop Sciences

Cowpea (Vigna unguiculata, L.) is an ancient field crop that has been grown in Oman. Little is known about the morphological and molecular diversity of cowpea in Oman. The objective of this study was to characterize and evaluate Omani cowpea accessions morphologically and genetically. A total of 25 accessions with 9 replication of each accessions were obtained from six different regions of Oman. At the morphological level, 17 qualitative and 6 quantitative characters showed variation among Omani cowpea accession and most traits were polymorphic. The standardized Shannon-Weaver diversity index (H) showed a mean 0.65 for quantitative characters higher than for qualitative characters (0.55). Overall, the morphological cluster analysis based on Ward's phenotypic diversity showed there was low genetic diversity with phenotypic distance of 180 within and between accessions obtained from different regions of Oman.

AFLP analysis of 25 cowpea accessions with three replication from Oman and five commercial varieties of cowpea from neighbouring countries using 6 primer pair combinations produced 3057 polymorphic loci (99%). Moderate levels of genetic diversity (0.214 - 0.316) were found among populations of cowpea accessions obtained from different regions, despite the long history of cowpea cultivation in Oman. AMOVA analysis indicated the low level of genetic differentiation (FST = 0.032) among populations of Omani cowpea accessions, which suggests the informal exchange manner of seeds between farmers is common in Oman. In addition, AMOVA analysis showed that only 3% of the genetic variation exists among populations of cowpea, which suggests a high level of gene flow (Nm =7.56) of cowpea accessions across geographical regions of Oman. Both analyses showed the Dhofar accessions were grouped in one subgroup and other accessions were intermixed in other subgroups.

Overall, this study confirmed both markers (morphological and molecular) used gave similar results, showing low amount of phenotypic diversity in Omani cowpea accessions. The AFLP analysis showed low level of genetic variation. The study also confirmed that AFLP markers can be used for accessions analysis and reliable diversity evaluation. This study clarifies the relationship between accessions of cowpea obtained from different 6 regions in Oman.

# Characterization of Gummosis Disease Associated with Acid Lime (Citrus aurantifolia Swingle) and Sweet Lime (C. limmettioides Tan.) in Oman

Student Name	:	Aisha Gharib Salim Al Ghaithi
Supervisor	:	Dr. Abdullah Al-Sa'di

Department : Crop Sciences

Citrus gummosis is the most destructive and serious fungal disease of citrus in the world. This study was conducted to characterize occurrence, distribution and casual agents of citrus gummosis in farms and nurseries in Oman. A survey over 2009 to 2011 which covered 17 wilayats and 166 farms showed that citrus gummosis occurs in 15% of acid lime farms and in 35% of sweet lime farms. Gummosis symptoms were also observed on mandarin, grapefruit, Tahiti lime, lemon and orange. A comprehensive survey in Samael in 2010 and 2011 showed association of citrus gummosis with "Round" and "Boo Reqab" cultivars of sweet lime. The disease was observed in 6 out of 9 villages in Samael, with Wadi Al-Saijani and Faghrah villages showing the highest incidence of the disease. Survey in commercial nurseries showed that citrus gummosis occurs on acid lime seedlings originating from Oman, Tahiti lime imported from Lebanon, sweet lime from Oman and Lebanon, orange from Syria and Egypt and mandarin from Syria. This provides evidence that seedlings imported from abroad could act as potential sources of citrus gummosis into Oman. Isolations from bark, root and soil samples obtained from diseased citrus trees and seedlings from farms and nurseries showed association of 30 fungal and oomycete species with citrus gummosis, with Lasiodiplodia theobromae and Fusarium solani being the most common. When these fungi and oomycetes were inoculated on acid lime and sweet lime seedlings, only L. theobromae, Pythium vexans, Neoscytalidium dimidiatum and F. solani reproduced citrus gummosis symptoms, with L. theobromae being the most aggressive. This study reports for the first time the presence of 13 new fungi and oomycetes to Oman. It also appears to be the first study to report association of *P. vexans* with gummosis symptoms in acid lime. The study recommends applying extension programs on citrculture for farmers in the most affected areas, applying strict quarantine measures to avoid introduction of new disease problems into Oman, and doing further studies on the casual agents of gummosis in other citrus species in the country.

# Characterization of Fungal Pathogens Associated with Foliar and Root Diseases of Six Plants at Oman Botanic Garden

Student Name	:	Zakiya Abdullah Nasser Al-Alawi
Supervisor	:	Dr. Abdullah Al-Sa'di
Department	:	Crop Sciences

Oman Botanic Garden (OBG) was established in 2006 to conserve, display and research the plants and ethnobotany of Oman. However, over one thousand seedlings and plants were killed over the previous years due to diseases of unknown etiology. This study was conducted to characterize the main fungal pathogens associated with foliar and root diseases of six native plants at OBG.

A survey over 2008 to 2010 which covered all OBG plants and seedlings showed that root rot, soft rot of stems, wilt symptoms, die back, leaf spots, canker and galls are the main disease symptoms associated with plants at OBG. Incidence of leaf spot disease in *Aloe dhufarensis, Cissus quadrangularis* and *Ficus sycomorus* was 100%, 95% and 30%, respectively. Mortality in *Crotalaria saltiana, Echidnopsis scutellata* and *Caralluma quadrangular* due to root rot and/or wilt diseases reached 75%, 60% and 45%, respectively.

Isolations followed by molecular-based identification of fungal pathogens showed that *Cladosporium cladosporioides* and *Alternaria alternata* were the most common pathogens associated with leaf spot diseases of the three native Plants. *Rhizoctonia solani, Fusarium solani* and *Pythium aphanidermatum* were the most common pathogens associated with root diseases of the other three native Plants. Investigating potting media, soil and water samples used at OBG for contamination with fungal and oomycete pathogens provided evidence that some wilt and leaf spot inducing fungi can be transmitted via potting media.

This is the first report of association of these pathogens with diseases in these six plants. The study recommends applying strict quarantine measures in OBG nursery, investigating management options for these diseases and doing further studies to know the pathogens associated with other native Omani plants.

# Assessment of Folate, Vitamin B6 and Vitamin B12 Status among Newly Diagnosed Omani Cardiac Patients

Student Name	:	Amira Humoud Mohammed Al Nassri
Supervisor	:	Dr. Mostafa Waly
Department	:	Food Science and Nutrition

Oman is currently witnessed a dramatic change in lifestyle and food choices as compared to the past, this was accompanied with an increase in the rate of morbidity and mortality from non-communicable diseases, including cardiovascular diseases (CVD).

This study was aimed to assess the nutritional and biochemical status of folate and vitamin B6 and vitamin B12 in relation to homocysteine level in newly diagnosed Omani cardiac patients.

A descriptive study approach was applied, and among 100 newly diagnosed Omani cardiac patients, only 25 cardiac (12 males and 13 females) were eligible in according to inclusion and exclusion criteria for this study.

Compared to reference values, the enrolled cardiac patients were overweight, had a history of hypertension, had hyperhomocysteinemia and showed significantly reduced levels of dietary intake of folate, vitamin B6 and vitamin B12 that is concomitant with low serum levels of these three nutrients. The study participants consumed high protein and saturated fats from animal sources in amount that exceeds the recommended daily dietary intake.

Our data supports previous reports suggesting hyperhomocystenemia and low status of folate, vitamin B6 and vitamin B12 are involved in the aetiology of CVD among high risk groups.

# Effect of Omani Date Palm (*Phoenix dactylifera* L.) Fruit (Naghal and 'Seedi) Extracts on the *In vitro* Fibrillization of Amyloid Beta-Protein

Student Name	:	Amjaad Saud Sulaiman Al-Ghammari
Supervisor	:	Dr. Mohammed Essa
Department	:	Food Science and Nutrition

Alzheimer's disease (AD) is the most common type of dementia characterized by loss of memory and factors such as cardiovascular disease, cancer, diabetes and traumatic brain injury, etc., may lead AD. Brain cells damage may be due to the accumulation of the protein Amyloid beta protein (AB) outside nerves cells, which leads to neuronal cell death. The mechanism of aggregation and fibrillization of AB is still unclear. The identification of compounds that can inhibit A $\beta$  fibrillization is expected to be the possible therapeutic and preventive value in AD. Studies suggest that natural products may delay the risk of AD. Dates palm fruit (Phoenix dactylifera, DPF) have been used in Middle Eastern countries for nutritional/ medicinal purposes and effect of some Omani date palm fruit varieties were showing inhibition for *in vitro* fibrillization of A $\beta$  was reported. Up to now no such studies were conducted by using four different growth stages (Khalal, Biser, Rutab and Tamr) of Omani DPF. To fill the information gab, the current study was performed to find out the effect of two DPF varieties for Oman namely Naghal and A'Seedi at their four stages of growth on the inhibition of A $\beta$  fibrillization under *in vitro* conditions. A $\beta$  fibrillization was assessed by using Thioflavin T fluorescence method and the levels of total phenolics content (TPC), total flavonoids content (TFC) and total antioxidant capacity (TAC) of the methanolic extracts of DPF were also analysed for all four stages of both varieties. Our results showed that 20µg of GAE methanolic extract of both DPF varieties offer a variable rate of inhibition of A $\beta$  fibrillization and displayed the levels of TPC, TFC and TAC in varying levels (P < 0.05). The highest inhibition rate of  $A\beta$  fibrillization was shown in the Khalal stage for Naghal, in the Biser stage for A'Seedi. Our data indicate that Omani dates palm fruit offer anti-amyloidogenic activity, which may be due to their polyphenolic compounds. However, the exact mechanism is still unknown and further preclinical and clinical studies are warranted.

# Instrumental Texture Profile Analysis (TPA) of Date-Tamarind Fruit Leather with Different Types of Hydrocolloids

Student Name	:	Karima Al-Waleed Zahir Al-Hinai
Supervisor	:	Prof. Mohd Shafiur Rahman
Department	:	Food Science and Nutrition

Date-tamarind fruit leathers could be developed by utilizing locally available date fruit and this could provide a value addition of the dates. In this work date-tamarind fruit leather was developed with varied textural attributes incorporating starch, pectin, dextrin and guar gum. All TPA attributes of controlled date-tamarind fruit leather (i.e. without any hydrocolloid) did not show any correlation with the moisture content ranges used in the present study. Hardness, gumminess and chewiness increased when hydrocolloids were added except chewiness in the case of dextrin, while cohesiveness, resilience and springiness decreased with the addition of hydrocolloids. Principal Component Analysis (PCA) identified 5 principal components (i.e. 5 factors: plasticity, elasticity, hydrocolloids' concentration, resilient. cohesiveness) affecting the characteristics of different date-tamarind fruit leather. The cluster analysis identified 4 classes of fruit leathers and bi-plot (i.e. including all products and their attributes) generated through PCA recognized these classes as hard-chewy, soft-springy, hard-fragile and softresilient leathers.

# Assessment of Folate and Vitamin B12 Status Among Newly Diagnosed Omani Autistic Children

Student Name	:	Maha Ali Abdullah Al-Khalili
Supervisor	:	Dr. Mostafa Waly
Department	:	Food Science and Nutrition

This study was aimed to assess the impact of folate and vitamin  $B_{12}$  status on homocysteine (HCY) levels in autistic Omani subjects. A case-control study approach was applied for this study and included 40 preschool-aged children newly diagnosed with autism spectrum disorders (ASDs) and 40 control subjects matched for age, and gender. Compared to controls, ASD cases showed significantly reduced levels of folate and vitamin  $B_{12}$  in both dietary intake and serum levels. Higher levels of homocysteine (HCY) were observed among ASD cases suggesting conclusive impairment of folatedependent HCY methylation. This data supports previous reports suggesting that low status of folate, vitamin  $B_{12}$  and hyperhomocyteinemia are significant risk factors for ASD.

## Evaluating Artisanal Fisheries Enforcement Program: A Case Study of the Ash-Sharqiyah South Governorate, Sultanate of Oman

Student Name	:	Al Mutasim Hammoud Ahmed Al-Habsi
Supervisor	:	Dr. Hussain Al-Masroori
Department	:	Marine Science and Fisheries

To ensure the sustainable use of the fisheries resources in the Sultanate of Oman requires effective enforcement of and compliance with fisheries management rules and regulations. To reduce the extent of fisheries noncompliance the Ministry of Agriculture and Fisheries initiated its Monitoring, Control and Surveillance (MCS) operations. The main objective of this study was to investigate and evaluate the process of fisheries enforcement as applied to the traditional sector.

The study was conducted in three wilayat of Ash-Sharqiyah South Governorate. A random sample of 100 fishermen from three wilayats and 20 enforcement officer was selected. The survey was carried out using face-toface interview with fishers and enforcement officials. The data and information collected on the subject-matter were analyzed using descriptive and inferential statistical techniques.

With respect to fishers' background profile, the results show that 39% of the fishers were above the average age of 34 years and 75% of the fishers have more than ten years of experience in the sector. It is noted that 85% of the interviewed fishers were vessel owner. It is also found that fishers (67%) are involved in multiple fisheries and they use multiple gears. Significant differences exist among fishers in regard to the overall law awareness and specific components of the law thereby indicating a communication gap between the authority and the fishers. In relation to fisheries violations 60%of the fishers think that the number of violations were same during the past two years. With respect to the participants' subjective probabilities, the null hypothesis for the following cases such as probability of violating again, probability of authority presence, probability of catch confiscation, probability of gear confiscation and probability of license confiscation was rejected at the 5% level. The results also indicate that fishers do not consider peer pressure and the probability of other fishers reporting violation to the authority. Although the subjective probabilities in relation to prosecution, conviction and penalty are relatively high the overall probability of conviction is affected by the low probability of detection. It is also noted that the results in regard to the probability of prosecution, conviction and penalty show similarity between the two stakeholder groups. Fisher's views from three study areas were similar in regard to the court process, penalty severity and the effectiveness of MCS and sanctioning. Enforcement officers view that fishers are very familiar with the law and that fishers consider severe penalties associated with non-compliance.

Based on the findings it is recommended that the enforcement authority should design an effective enforcement plan by considering the issues identified in this study and design appropriate strategies to prevent noncompliance. It is also important to strengthened the current enforcement programs by negotiating a join enforcement approach with key stakeholders.

It is hoped that the findings from this study will encourage further research in this important area and provide useful information to the Ministry of Agriculture and Fisheries so that effective enforcement strategies can be formulated.

### The Impact of High Food Prices on the Welfare of Households in Oman

Student Name	:	Ahmed Salim Said Al-Shamakhi
Supervisor	:	Dr. Houcine Boughanmni
Department	:	Natural Resource Economics

Oman has experienced one of the highest domestic food inflation rates in the Middle East during the period from 2006 to 2008. The high food inflation prompted public discussions and debates over its effects on households and the policies required to insure the short term and long term food security.

The objective of this study is to analyze the household consumption patterns and evaluate the impact of high food prices during the 2006-2008 food crisis period on the welfare of households in the Sultanate of Oman.

The welfare impacts of price changes are estimated using the Hicksian Compensating-Variation (CV) methodology. In a policy context, the CV represents the money transfer required to compensate households for the inflationary pressure that occurres during the food crisis period. The CV were estimated for 4 different income household groups as well as two location groups (urban-rural) so as to recognize that different groups are affected differently by the price change. The compensating variation computation required the need to estimate a full demand system, incorporating 9 food commodities, and in which detailed households characteristics are included. Data used in the analysis includes the year 2000 Household Expenditure and Income Survey conducted by the Ministry of National Economy as well as the summary data of the same survey in year 2008. The analyses of the household consumption patterns indicates that although food expenditure share has declined slightly over time due to increased income, the average Omani household still spends a large proportion of total expenditure on food (28%). The food basket of Omani households has been stable over time with meat, food from restaurants, cereals, and dairy as the main items. The only exception is the significant increase in restaurant food expenditure share and the significant decrease in consumption share of food from "own production". The increased reliance on the market and food "away from home" increases the vulnerability of low income households to price increases and raises a nutritional concern that the government has to address.

Results suggest that all household groups suffered welfare losses due to the food crisis. On average, Omani households need to be compensated about 10.3% of their income for the price increase they experienced during the

2006-2008 period. Rural households are more affected than urban households with a required compensation of 12.4% and 9.87% respectively. In all cases most of the impact is felt on the first round where no consumption adjustment is made; the second round effect is comparatively small compared to the first-order effect. The reason for this discrepancy is that little substitution occurred in consumption because the price increase has touched almost all food commodities that are important to the Omani household food basket.

# Multi-Period Dynamic Linear Programming Analysis Determining the Optimal Replanting Age of Date Palm

Student Name	:	Amani Juma Thuwaini Al Alawi
Supervisor	:	Dr. Hemesiri Kotagama
Department	:	Natural Resource Economics

Date palm is the most significant crop, culturally and socio-economically, in the Sultanate of Oman. Since year 2000 onwards the cultivated extent, productivity and production of date palm have stagnated. Nearly 37% of the date palms in the Sultanate of Oman are more than 50 years old. The government of the Sultanate has implemented a program to rejuvenate the sector by planting 1 million date palms. Date palm could be planted as newplantings requiring additional land, water and other resources and/or be replanted substituting aged and unproductive palms without additional commitment of land, water and other resources. Replanting of perennial crops is an agronomic practice that maximizes and sustains long-term benefits. Although the optimal age of replanting of several perennial crops have been scientifically estimated, the optimal age to replant date palm has not yet been scientifically examined. This study estimated the optimal age to replant date palm.

Two alternative analytical models were used to estimate the optimal age of replanting of date palm, namely; Comparison of Equivalent Annual Net Revenue (CEAN) and Multi-Period Dynamic Linear Programming Model (MPDLP). Solution procedures of both models are based on the theory of optimal replacement of capital assets. Data on date palm age-yield relationship and other socio-economic variables were gleaned through a farm survey of 34 large commercial farms, in Izki, Bahla, and Al-Hamra wilayats in the Al-Dakhilya governorate.

The khalas date palm variety was considered for the study. The age yield relationship that was estimated was:  $Y = -3.6943X^2 + 48.846X + 19.105$  ( $R^2 = 0.5735$ ),-*ceteris-paribus*. Where Y is the Yield (Kg) per palm and X was the Age (Years) of the palm. The base data used to solve the model were: average price of date 0.250 OR/, cost of cultivation 914 OR/hectare, 125 date palms per hectare and an interest rate of 4%.

The study estimated the optimal age of replanting date palm as 50-55 years. Both models, CEAN and MPDLP gave consistent estimates. The optimal age to replant date palm was sensitive only to changes in the interest rates. Low interest rates shortened the optimal age of date palm replanting. Changes in
price, yield and cost did not change the optimal age of replanting of date palm.

The study derived the optimal replanting schedule for date palm for the Sultanate of Oman given the current age distribution of date palms. The incremental revenue to the Sultanate of Oman through replanting of date palm was estimated to be 7 million OR/ year. Thus the Sultanate of Oman could increase the revenue from the date palm sector by about 13% as of the revenue of the sector of 2011 (52.6 million OR), by adopting the derived replanting schedule. The findings of the study suggest the benefits of implementing a date palm replanting program to improve the date palm sectors' contribution to the society and to the economy of the Sultanate of Oman. The government could plan and implement such a program, whilst providing guidance and appropriate incentives for farmers to adopt date palm replanting. The methodology and the models developed in this study could be useful tools for planning such a program at a national and farm level.

# International Collaborations

# **International Collaborations**

Table15.	International	collaborations	in	2012.
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No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
Anim	al and Veterinary Sciences	:	
1	University of Porto, Portugal	Collaborative research (HM project)/ Dr. Albano Fereira	Prof. O.M. Gaafar/ Training Omanis and helping with DNA analyses
2	Al-Farabi Kazah National University Kazakhstan	Collaboration research (PhD student)	Prof. Isam T. Kadim/ Training a PhD student with meat quality characteristics
3	University of Kassel and University of Goettingen, Germany	Prof. Dr. Eva Schlecht	Prof. O.M. Gaafar/ Animal husbandry in the tropics and subtropics
4	University of Kassel, Germany	Prof. Dr. Andreas Buerkert	Prof. O.M. Gaafar/ Organic plant production and agroecosystems Research in the tropics and subtropics
Crop	Sciences		-
5	University of Florida, USA	Research / Prof. Bruce Schaffer	Dr. Rashid Al- Yahyai/ Tropical fruit production research
6	UCD School of Agriculture, Food Sciences & Vet Med, Ireland	Postgraduate Research / Dr. Owen Doyle	Dr. Rashid Al- Yahyai/Prof. Michael Deadman Ornamental Plant Research
7	Laboratory of Phytosanitary Biotechnologies, Science and Technology Park of Sicily, Italy	Tristeza virus, Dr. Grazia Licciardello	Dr Abdullah Al-Sadi, Genomics and analysis

## Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
8	Science and Technology Park of Sicily, Italy	Tristeza virus, Antonino Catara	Dr Abdullah Al-Sadi, Genomics and analysis
9	Genomics Laboratory Weill Cornell Medical College in Qatar	WBDL, Dr. Joel A. Malek	Dr Abdullah Al-Sadi, Genomics and analysis
10	Instituto de Biologia Molecular y Celular de Plantas, Spain	Tristeza virus, Dr. Jesús A. Sánchez Navarro	Dr Abdullah Al-Sadi, Techniques for detection of viruses
11	Abu Dhabi Food Control Authority, UAE	Acid lime diseases, Rashid Al- Shariqi, Director General	Dr Abdullah Al-Sadi, New diseases of citrus
12	Nottingham University, UK	WBDL, Prof. Matthew Dickinson	Dr Abdullah Al-Sadi Techniques for detection of phytoplasma
13	Dept of Agriculture The University of Reading, UK	Supervision of Omani PhD students/ Dr. S.R. Gowen	Prof. M. Deadman/ Capacity building for Oman
14	Environmental Studies Centre, Univ. of Surrey, UK	Supervision of Omani PhD student/ Professor Steve Morse	Prof. M. Deadman/ Capacity building for Oman
15	University of Perdue, USA	Molecular identification of plant pathogenic fungi/ Professor Cathie Aime	Prof. M. Deadman/ Development of a compendium of plant pathogens in Oman
16	Faculty of Agriculture Dalhousi University, Canada	Research/ Dr. Q. Zaman, Chair, Precision Agriculture	Dr. Mumtaz Khan/ Precision farming
17	International Rice Research Institute (IRRI) Phillipines	Research/ Prof. Paul Quick,	Dr. Mumtaz Khan/ Metabolomics, abiotic stress mechanism
18	Primary Industries, New South Wales, Australia	Research, Material transfer/ Dr T. Khurshid	Dr. Mumtaz Khan/ Citrus variety testing research
19	CREC, University of Florida , USA	Lime hybrids testing (WBDL)/ Prof. J. Grosser	Dr Mumtaz Khan/ Citrus/Lime

Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
Food	Science and Nutrition		
20	University of Tunis II- Ecole Supérieure des Industries Alimentaires, Tunisia	<b>Collaborative research/</b> Dr. Salwa Bornaz	Dr. N. Guizani
21	Dept of Pharmacology University of New South Wales, Australia	Collaborative research/ Prof. Gilles J Guillemin	Dr. M.Essa
22	Washington State University, USA	Collaborating in research and publishing books / Dr. Mushtaq A Memon	Dr. M.Essa
23	National Institute of Health, USA	Collaborating in research and publishing books / Dr. Mohammed Akbar	Dr. M.Essa
24	Nagasaki International University, Japan	Collaborating in research / Prof. Yukihiro Shoyama	Dr. M.Essa
25	Developmental Neuroscience NYSIBR, USA	Collaborative research/ Dr. Ted Brown/Abha Chauhan	Dr. M. Essa
26	Department of Nutritional Sciences, University of Toronto	Scientific collaboration/ Emeritus Prof. A.V. Rao and Prof Nancy Kreiger	Dr. A. Ali
27	Department of Pharmacology, University of Sargodha, Pakistan	Scientific research collaboration/ Prof. M. S. Akhtar	Dr. A. Ali
Mari	ne Science and Fisheries		
28	Indian Institute of Science, Bangalore, India	Research/Dr. P. N. Vinayachandran	Dr. Y.V.B. Sarma/ Development of numerical modeling facility at SQU
29	Indian National Center for Ocean Information Services, Hyderabad, India	Data/Dr. S. Shenoi	Dr. Y.V.B. Sarma

Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
30	University of Maryland, Center for Environmental Science, Horn Point Laboratory	To study nutrient uptake and phytoplankton ecology/ Prof. Patricia Glibert	Dr. A. Al Azri
31	Bigelow Lab in Maine, USA	Scientific research on Arabian sea project/Impact of global warming on phytoplankton blooms/ Dr. Joaquim Goes and Helga Gomes	Dr. A. Al Azri
32	Rosentiel School of Marine and Atmospheric Science, USA	Joint project - study interaction of phyto- plankton and zooplankton in upwelling region/ Prof. Sharon Smith	Dr. A. Al Azri
33	International Islamic University of Malaysia (IIUM)	Joint Research	Dr. S. Al Barwani
34	University of British Columbia	Re-construct catches of fishes in Oman from 1950 to the present time/ Prof. Daniel Pauly	Dr A. Govender
35	Florida Museum of Natural History	Taxonomy / Gustav Paulay	Dr. M.R. Claereboudt/ Acquisition of taxonomic expertise, identification of specimen
36	Unversity of Vienna, Dept. of Paleontology	Taxonomy of bryzoans and biodiversity / Andrei Ostrovsky	Dr. M.R. Claereboudt/ Identification of bryozoans
37	Dusseldorf University Germany	Knowledge transfer/ Prof. Peter Proksch	Dr. S. Dobretsov/ Several manuscripts were published/ Identiication of natural products

### Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
38	Roskilde University, Denmark	Visits exchange, knowledge transfer / Prof. Benni Hansen	Dr. S. Dobretsov/ 1 MSc and 1 PhD students were working at MSF. There are perspective of the future publications
39	Smithsonian Marine Station, USA	Visits exchange, knowledge transfer/ Prof. Valerie J Paul	Dr. S. Dobretsov/ Several joint publications were published
40	Marine Ecological Services, France	Visits exchange, knowledge transfer/ Dr. Jeremy Thomason	Dr. S. Dobretsov/ One (1) joint publication was published
41	King Abdullah University of Science and Technology <i>(</i> KAUST <i>), Saudi Arabia</i>	Visits exchange, knowledge transfer/ Dr. Chris Voolstra	Dr. S. Dobretsov/ Worked on coral microbial symbionts
42	California University, USA	Analysis of mesoscale eddies of the Arabian Sea. Dr.Nik Nezlin	Dr.S.Piontkovski/ Series of joint papers
43	NOAA/Climate Lab., USA	Assembly of historical data. Syd Levitus and Alex Mishon	Dr.S.Piontkovski/ Assembly of the Arabian Sea database
44	Institute of Biology of the Southern Seas, Ukraine	Taxonomy of zooplankton. Dr.Alexandra Gubanova	Dr.S.Piontkovski/ Series of joint papers
45	University of Western Australia, Australia	Modeling of physical dynamics in the Sea of Oman/Drs. Greg Ivey and Michael Meuleners	Dr.S.Piontkovski/ New proposal for TRC funding
46	Qatar University, Qatar	Algal blooms development. Abdulrahman AlMuftah	Dr.S.Piontkovski/N ew proposal for Qatar Research Fund

Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
Natu	ral Resource Economics		
47	Department of Agribusiness and Consumer Sciences, UAE University, Al-Ain, UAE	Research project: Market potential of organic food products in GCC countries/Dr. Safdar Muhammad	Dr. H. Boughanmi Research publications Regional recognition of SQU
48	Department of Economics, School of Business and Economics, Thompson Rivers University (TRU) Kamloops, British Columbia, Canada	Collaborative research on local government decision- making in Canada and on financial markets in developing countries/ Dr. H. Rahman	Conference presentation Research publications International recognition of SQU expertise
Soils	, Water and Agricultural	Engineering	
49	International Center for Biosaline Agriculture (ICBA)	Collaborative research/ Dr. Shabbir Shahidq	Dr. S. Al-Rawahy/ Provided seeds for field trials and technical assistance
50	Dept. of Biosystems Engineering, Washington State Univ.	Writing a paper on a joint research work	Dr. Y. Al-Mulla
51	Rhodes University, South Africa	Collaborative research/ Dr. Roman Tandlich	Dr. M. Ahmed
52	Kazan State University, Russia	Collaborative research/ Prof. Y. Obsonov	Dr. M. Ahmed
53	University of Highlands & Islands, UK	PhD Supervision/ Prof. Martin Price	Dr. M. Ahmed
54	AGU, Bahrain	External Examiner	Dr. H. AbdelRahman
55	Journal of Land Degradaation and Development, Spain	Journal article review/ Prof. Artemi Cerdà	Dr. H. AbdelRahman
56	University of Nebraska, USA	Collaborative research/MAR Prof. Vitaly Zlotnik	Dr. Ali Al-Maktoumi

Table 15 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Person/ Extent of Benefit
57	California Institute of Technology/USA	Collaborative research/ Radar probing of groundwater in hyper-arid environments/ Prof Jean Philippe Avouac	Dr. Ali Al-Maktoumi
58	University of Utrecht/University of Amsterdam - The Netherlands	Collaborative research/ Suspended solids filtration in porous medium Dr. Roud Shooting	Dr. Ali Al-Maktoumi
59	UNESCO – IHE and University of Utrecht/The Netherlands	Collaborative research/ feasibility of Managed Aquifer Recharge in lower Samail catchment/ Dr. Andreja Jonoski	Dr. Ali Al-Maktoumi
60	University of Putra Malaysia / Malaysia	Collaborative Research/ numerical modeling of seawater intrusion mechanisms in Salalah Plain aquifer, Oman/ Dr. Thamer Ahmed	Dr. Ali Al-Maktoumi
61	University of Manitoba	Collaboration in PhD Student Research (Teena)/Summer training at University of Manitoba/ Prof. Digvir Jayas Co-Supervision of PhD student (Mr. Chelladurai)	Dr. Manickavasan
62	University of Minnesota	Collaboration in Whole Grains Project/ Prof. Marla Reicks	Dr. Manickavasan

# Publications in 2012

# **Publications in 2012**

CAMS faculty published a total of 268 scientific documents among which 99 were peer-reviewed journal articles. They also contributed to 8 books (7 edited) and 21 articles in conference proceedings (Table 16).

**Table 16.** Summary of total publications in 2012.

Technical Report Booklet	21 1	
Posters – 14; Abstracts – 4)	21	
(Proceedings – 21; Papers presented – 69;		
Conference presentations	108	
Chapter in Books	31	
Books Edited	7	
Book	1	
Refereed Journal	99	
Refereed Journal	00	

#### **Refereed Journal**

- Agustini, T. W., Eko, S., Al-Bulushi, M. I., & Rahman, M. S. (2012). Effect of alloe vera (*Alloe vera*) and crown of god fruit (*Phaleria macrocarpa*) on sensory, chemical, and microbiological attributes of Indian mackerel (*Restrelliger neglectus*) during ice storage. *International Food Research Journal*, 19(1), 119-125.
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- Al-Hashmi, K. A., Sarma, Y. V. B., Claereboudt, M. R., Al-Azri, A. R., Piontkovski, S., & Al-Habsi, H. (2012). Phytoplankton community structure in the Bay of Bandar Khayran, Sea of Oman, with special reference to harmful Algae. *International Journal of Marine Science*, 2(5), 31-42. doi: 10.5376/ijms.2012.02.0005
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- Bobade, P. A. (2012). Ticks infesting goats in the mountainous area of Jabal Akhdar in Oman. In: Proceedings of the Annual Conference of the British Society of Animal Science (BSAS) & the Association of Veterinary Teaching and Research Work (AVTRW), p. 181. 24-25 April 2012.
- El Tahir, Y., Johnson, E. H., Nair, R. R., & Al Araimi, A. (2012). Binding of Bp26, a Brucella periplasmic protein to extracellular matrix molecules. In: Proceedings of the 112th General Meeting of the American Society for Microbiology, San Francisco, California, USA, p. 215. 16-19 June 2012.
- El Tahir, Y., Mohammed Ali, H., Mansour, M. H., & Mahgoub, O. (2012). Serum mineral content of Omani racing Arabian camels (Camelus dromedarius) (Poster). In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development,

Muscat, Sultanate of Oman, 393-394. 29 January -01 February 2012.

- Kadim, I. T., Al-Kharousi, A., Mahgoub, O., R., A.-M., & Khalaf, S. (2012). Quality characteristics of Infraspinatus, Triceps brachii, Longisimus thoracis, Biceps femoris, Semitendinosus and Semimembranosus muscles of dromedary (Camelus dromedarius) camel. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 191-192. 29 January - 01 February 2012.
- Mahgoub, O., Kadim, I. T., Al-Marzooqi, W., Al-Lawati, S. M., & Al-Abri, A. S. (2012). Distribution and measurements of bone in the Omani camel carcass. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 202-203. 01 January-01 February 2012.
- Mahgoub, O., Kadim, I. T., Al-Marzooqi, W., Al-Lawatia, S. A., & Al-Abri, A. S. (2012). Water intake in Omani camels kept on various levels of feed intake. (Poster). In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 395-396. 29 January-01 February 2012.
- Mahgoub, O., Tageldin, M. H., Nageeb, A., Al-Lawatia, S. A., Al-Busaidi, M. H., Al-Abri, A. S., & Johnson, E. H. (2012). An outbreak of severe dermatophylosis in young Omani camels. (Poster). In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 321-322. 29 January - 01 February 2012.
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- Manickavasagan, A., Thomas, G., Al-Yahyai, R., & Hema, M. (2012). Brightness preserving histogram equalization (BPHE) technique for classification of dates. In: Proceedings of the International Conference on Computational Vision and Robotics, Bhubaneswar, India, 1-3. 19 August 2012.
- Mathan Kumar, S., & Johnson, E. H. (2012). A survey on antimicrobials utilized in camel practice by veterinary practitioners in Oman. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 52-54. 29 January - 01 February 2012.
- Mathan Kumar, S., Johnson, E. H., & Tageldin, M. H. (2012). Most common medical conditions of camels in Oman observed by veterinarians in private practice: a practitioner survey. (Poster). In: Proceedings of the 3rd Conference of the International Society of

Camelid Research and Development, Muscat, Sultanate of Oman, 319-320. 29 January - 01 February 2012.

- Mathan Kumar, S., Johnson, E. H., & Tageldin, M. H. (2012). Wasm-an ethnoveterinary practice for treatment of camels in Oman. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 81-83. 29 January - 01 February 2012.
- Mbaga, D. M. (2012). The economic potential of the Dromedary camel meat. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman, 185-187. 29 January - 01 February 2012.
- Tageldin, M. H., Abu Damer, H., Adam, M. A., & Ishmael, O. N. (2012). Subclinical goiter in camels (Camelus dromedarius) in the Dhofar Region of Oman. In: Proceedings of the 3rd Conference of the International Society of Camelid Research and Development, SQU, Sultanate of Oman, 98-99.
- Weerahewa, J., Kodithuwakku, S. S., & Buhari, R. (2012). Agricultural export diversification in Sri Lanka: an analysis of intensive and extensive margins during 2000-2010. In: Proceedings of the 1st International Economic Research Conference of the Sri Lanka Forum of University Economists, Colombo, 117-120. 29-30 November 2012.
- 21. Weerahewa, J., Kodithuwakku, S. S., & Buhary, R. (2012). An analysis of export performance of enterprises in Sri Lanka. In: Proceedings of the ARTNeT Conference on Empirical and Policy Issues of Integration in the Asia and the Pacific, Colombo. 1-2 November 2012. http://www.unescap.org/tid/artnet/mtg/epii.asp.

#### **Papers Presented**

- Abed, R. M. M., Al-Sadi, A. M., Al-Shehi, M. A., Al-Hinai, S., & Robinson, M. D. (2012). *Diversity and function of fungal communities in biological soil crusts in Oman*. Paper presented at the 14th International Symposium on Microbial Ecology-ISME-14, The Power of the Small, Copenhagen, Denmark. 19-24 August.
- Abed, R. M. M., Dobretsov, S., & Vaksmaa, A. (2012). Substrate background affects formation of micro- and macro-fouling communities. Paper presented at the 16th International Congress on Marine Corrosion and Fouling, Seattle, USA, 24-28 June.
- Ahmed, M. (2012). Climate change and water resources management: options for water stressed countries. Paper presented at the 4th IASTER African Conference on Water Resources Management (AfricaWRM 2012), Goborone, Botswana, 03-05 September.
- 4. Al-Azri, A., Al-Hashmi, K., Piontkovski, S., & Sarma, Y. V. B. (2012). Harmful algal blooms in coastal water of Oman: An emerging threat to marine communities. Paper presented at the 50th ECSA

Conference: Today's Science for Tomorrow Management, Venice, Italy, 3-7 June.

- Al-Barwani, S. (2012). Population structure and stock assessment of Perna perna at Ras Madraka in Oman. Paper presented at the Malaysia International Biological Symposium 2012, Selangor, Malaysia, 11-12 July.
- Al-Barwani, S., & Goddard, J. S. (2012). Heavy metals in marine sediments and rock oysters in Oman. Paper presented at the Sultan Qaboos University Day 2012, Muscat, Oman, 2 May.
- Al-Barwani, S., Goddard, J. S., Kamaruzzaman, Y., Khan, A. J., Shahbudin, S., & Zahir, M. S. M. (2012). Heavy metals in rock oysters, Saccostra cucullata and brown mussels, Perna perna from the Arabian Sea and the Sea of Oman. Paper presented at the Australasian Aquaculture, Melbourne, Australia, 1-4 May.
- 8. Al-Bulushi, I. (2012). Incidence of pathogens and amino acids decarboxylating bacteria in traditionally dried anchovies. Paper presented at the FOODMICRO 2012, Istanbul, Turkey, 03-07 September.
- Al-Busaidi, A., Ahmed, M., & Choudri, B. S. (2012). Climate change in Oman: current knowledge and way forward. Paper presented at the International Conference on Planet under Pressure, Excel London, UK, 25-29 March.
- Al-Busaidi, A., & Al-Mahruki, H. (2012). The influence of magnetically treated irrigation water on land productivity and plant growth. Paper presented at the Symposium on Environmental Problems in the Arab World. Meeting the Environmental Challenges of Sustainable Development, College of Arts, Sultan Qaboos University, Muscat, Sultanate of Oman, 26-28 February.
- Al-Habsi, K. A., Al-Subhi, A. M., & Khan, M. (2012). Tabseel traditional date palm post-harvest method in Oman. Paper presented at the 7th International Postharvest Symposium IPS 2012), Kuala Lumpur, Malaysia, 25-29 June.
- Al-Haddabi, M., & Ahmed, M. (2012). Management of oily-produced water. Paper presented at the Symposium on Environmental Problems in the Arab World: Meeting Challenges of Sustainable Development, College of Arts, Sultan Qaboos University, Muscat, Sultanate of Oman, 26-28 February.
- Ali, A. (2012). Nutritional quality of indigenous Omani legumes and their significance in human nutrition. Paper presented at the 7th International CIGR Technical Symposium "Innovating the Food Value Chain", University of Stellenbosch, Stellenbosch, South Africa, 25-29 November.
- Ali, A., Waly, M., Essa, M. M., & Sankar, D. (2012). Role of whole grains in reducing the risk of chronic diseases. Paper presented at the International Symposium on Whole Grain Production, Muscat, Oman, 14-15 April.

- Al-Ismaili, A., Weatherhead, E. K., & Jayasuriya, H. P. W. (2012). Mathematical simulation of the dehumidification of seawater greenhouse. Paper presented at the International Conference of Agricultural Engineering, CIGR-Ageng 2012, Valencia, Spain, 8-12 July.
- Al-Ismaily, S., Al-Maktoumi, A. K., Kacimov, A., Al-Saqri, S., Al-Busaidi, H., & Al-Haddabi, M. (2012). A hydropedological morphed blockcrack capillary barrier: human influence and lessons from nature. Paper presented at the 2012 International Annual Meetings of SSSA: Visions for a Sustainable Planet, Cincinnati, USA, 21-24 October.
- 17. Al-Jabri, S., Ahmed, M., Al-Maktoumi, A., & Prathapar, S. A. (2012). Potential of managed aquifer recharge of treated wastewater in the governorate of Muscat, the Sultanate of Oman. Paper presented at the Hydrogeology of Arid Environment Conference, Hannover, Germany, 14-17 March.
- Al-Mulla, Y. A. (2012). Water conservation through controlled environment agriculture. Paper presented at the Symposium on environmental problems in the Arab World: Meeting challenges of sustainable development, College of Arts, Sultan Qaboos University, Muscat, Sultanate of Oman, 26-28 February.
- Al-Qamshoui, B. A., Weigend, S., Simianer, H., & Mahgoub, O. (2012). Assessment of genetic diversity and population structure of Omani local chicken using 29 microsatellites. Paper presented at the Tropentag 2012: Resilience of agricultural systems against crises, Göttingen - Kassel/Witzenhausen, Germany, 19-21 September.
- Al-Rawahi, A., & Rahman, M. S. (2012). Thermal characteristics of water soluble extract obtained from pomegranate skin: developing a state diagram. Paper presented at the Food Innovation Asia Conference, Bangkok, Thailand, 14-15 June.
- Al-Rawahi, A., Rahman, M. S., Guizani, N., & Essa, M. (2012). Chemical composition, water sorption isotherm and phenolic contents in fresh and dried pomegranate peels. Paper presented at the International Conference on Food and Nutrition Technology for Public Health, IISMAAS, New Delhi, India, 4-5 May.
- Al-Rawahy, S., & Ahmed, M. (2012). An adaptation strategy for managing soil salinity in Oman. Paper presented at the Symposium on Environmental Problems in the Arab World: Meeting challenges of sustainable development, College of Arts, Sultan Qaboos University, Muscat, Sultanate of Oman, 26-28 February.
- Al-Riyami, S. A., Bobade, P. A., Al-Busaidi, R. M., Heyne, H., & Latif, A. (2012). *Ticks (Acarina: Ixodidae) of livestock in Oman.* Paper presented at the 1st Regional Conference of the Society for Tropical Veterinary Medicine, Phuket, Thailand, 18-21 June.
- Al-Sadi, A. M., & Al-Harthi, S. A. (2012). Viral and viral-like diseases of citrus in Oman. Paper presented at the International Citrus Congress, Valencia, Spain, 18-23 November.

- Al-Sadi, A. M. A.-Y., R.A., & Al-Said, F. A. (2012). Witches' Broom Disease of Lime, a serious disease of acid lime (Citrus aurantifolia) in the Arabian Peninsula. Paper presented at the International Citrus Congress, Valencia, Spain, 18-23 November.
- Al-Said, F. A. (2012). Pomegranate cultivation in Oman. Paper presented at the 2nd All Africa Horticulture Congress, Shukuza, South Africa, 15-20 January.
- Al-Shihi, A. A., & Khan, A. J. (2012). Management of whitefly transmitted begomovirus associated with tomato in Oman. Paper presented at the XV International Congress of IS-Molecular Plant-Microbe Interaction, Kyoto, Japan, 29 July - 02 August.
- Al-Subhi, L. (2012). Piloting a culturally sensitive diabetes education program: training educators. Paper presented at the IDF/MENA Regional International Diabetes Conference, Doha, Qatar, 14-16 December.
- Al-Yahyai, R., Al-Said, F., Al-Kharusi, L., & Al-Lawati, T. (2012). Fruit quality attributes of Citrus aurantifolia infected with Witches' Broom Disease of Lime. Paper presented at the 2nd All Africa Horticulture Congress "Horticulture for Humanity", Skukuza, South Africa, 15-20 January.
- Al-Yahyai, R., Al-Said, F., Khan, I., & Al-Kharusi, L. (2012). Postharvest fruit quality characteristics of selected Citrus species grown in Oman. Paper presented at the 2nd International Conference on Postharvest technology and Quality Management: Postharvest Africa 2012, Stellenbosch, South Africa, 24-29 November.
- Al-Yahyai, R., & Manickavasagan, A. (2012). Fruit quality of date palm: Influencing factors and assessment methods. (IPS 2012). Paper presented at the 7th International Postharvest Symposium 2012, Postharvest for Wealth & Health, Kuala Lumpur, Malaysia, 25-29 June.
- Basunia, M. (2012). Predictability of the two commonly-used models to represent the thin-layer rewetting characteristics of barley. Paper presented at the International Conference on Agricultural & Biosystems Engineering (ICABE 2012), Perth, Australia, 06-07 December.
- 33. Belwal, R., & Al Jabri, O. (2012). Training needs analysis of fishermen on the Oman's Batinah Coast: an exploratory analysis. Paper presented at the Food and Agricultural Organization of the United Nations-European Inland Fisheries and Aquaculture Advisory Commission (FAO-EIFAAC) Symposium Towards Responsible Future in Inland Fisheries Management-related Collaboration in Inland Fisheries and Aquaculture, Hämeenlinna, Finland, 21-25 October.
- 34. Bobade, P. A., Al-Busaidi, R. M., & Latif, A. (2012). First report of the presence of Ehrlichia ruminatium in goats in Oman. Paper presented at the 1st Regional Conference of the Society for Tropical Veterinary Medicine, Phuket, Thailand, 18-21 June.

- 35. Choudri, B. S., Al-Busaidi, A., & Ahmed, M. (2012). Vulnerability of farmers to climate change and adaptation strategies: A case study of Al-Batinah, Oman. Paper presented at the International Conference in Climate Adaption: Adaptation Futures 2012, University of Arizona, Tucson, USA, 29-31 May.
- Claereboudt, E. J., & Claereboudt, M. R. (2012). Quantifying the covering behavior of the urchin Toxopneustes pileolus by image analysis. Paper presented at the 14th International Conference on Echinoderm, Brussels, Belgium, 20-24 August.
- Claereboudt, M. R., & Al-Rashdi, K. M. (2012). Echinoderm diversity, biogeography and abundance along the shores of the Sultanate of Oman. Paper presented at the 14th International Conference on Echinoderm, Brussels, Belgium, 20-24 August.
- 38. Deadman, M. L., Al-Said, F. A., & Al-Sadi, A. M. (2012). Integrated management of plant diseases in greenhouse cropping systems: The Oman experience. Paper presented at the Integrated Disease Management Workshop, Abu Dhabi, UAE, 12 March.
- Dobretsov, S., Abed, R., & Al-Fori, M. (2012). Extremely hypersaline isolates from microbial mats exhibit quorum sensing quenching and anti-microbial properties. Paper presented at the14th International Symposium on Microbial Ecology, Copenhagen, Denmark, 19-24 August.
- Dobretsov, S., Al Wahaibi, A., Claereboudt, M. R., & Soussi, B. (2012). Biotechnological potential of Oman soft corals. Paper presented at the Gulf Coral Reef Conference, Abu Dhabi, UAE, 17 January.
- 41. Dobretsov, S., & Thomason, J. (2012). A fluoropolymer fouling release coating significantly resists the initial development of biofilms. Paper presented at the 16th International Congress on Marine Corrosion and Fouling, Seattle, USA, 24-28 June.
- 42. Govender, A., & Sarma, Y. V. B. (2012). Analysis of sea surface temperature in distinct oceanographic basins off Oman: the Sea of Oman and Arabian Sea. Paper presented at the Coral Reefs of the Gulf Conference, Abu Dhabi, UAE, 17-19 January.
- 43. Guizani, N., Rahman, M. S., & Essa, M. (2012). In-vitro antioxidant activities of three date varieties (Phoenix dactylifera L.) from Sultanate of Oman at two edible maturity stages. Paper presented at the International Conference on Agricultural Engineering, CIGR-Ageng 2012, Valencia, Spain, 8-12 July.
- 44. Jayasuriya, H. P. W., Swain, K. C., & Samseemoung, G. (2012). Potential applications of low-altitude remote sensing (LARS) with radio-controlled helicopter platforms: Case studies on nutrient and pest management under agriculture systems in developing countries. Paper presented at the 11th International Conference on Precision Agriculture, Indianapolis, USA, 15-18 July.
- 45. Kacimov, A. (2012). Capillary siphoning as an irrigation technique of green roof modules of an ecohouse in arid climates: from Richards' and Washburn-Lukas models to engineering design. Paper

presented at the International Conference "Flow and Transport in Porous Media", Poros Island, Greece, 17-21 April.

- 46. Kacimov, A., S., A.-I., A., A.-M., Kasimova, R., Obnosov, Y., Al-Issai, J., M., A.-A., Al-Balushi, M., & Al-Busaidi, H. (2012). Capillary siphoning as an irrigation technique of green roof modules of an ecohouse in arid climates: from Richards' and Washburn-Lukas models to engineering design. Paper presented at the 19th European Conference on Fracture (ECF19) Kazan, Russia, 26-31 August.
- Kadim, I. T., & Mahgoub, O. (2012). Effects of hot season and electrical stimulation on meat quality characteristics of goat longissimus dorsi muscle. Paper presented at the XI International Conference on Goats (ICG 2012), Gran Canaria, Spain, 23-27 September.
- 48. Kadim, I. T., & Mahgoub, O. (2012). *Nutritive value and medical benefits* of camel meat. Paper presented at the First National Congress of Camel in Iran, Mashahd, Iran, 17-18 April.
- 49. Kadim, I. T., Mahgoub, O., Al-Karousi, A., & Raiymbek, G. (2012). Comparison of meat quality parameters between Dromedary (Camelus dromedarius) and Bactrian (Camelus bactrianus) camel muscles. Paper presented at the Conference of Sustainability of Camel Population and Production, King Faisal University, Saudi Arabia, 17-20 December.
- 50. Khan, A. J., Al-Zaidi, A. M., & Akhtar, S. (2012). Molecular characterization of chili leaf curl virus and satellite DNA associated with tomato in Oman. Paper presented at the XV International Congress on Molecular Plant Microbe Interaction, Kyoto, Japan, 29 July - 02 August.
- 51. Kotagama, H., Al-Jabri, S. A. N., Boughanmi, H., & Guizani, N. (2012). Impact of food prices, income and income distribution on food security in Oman. Paper presented at the 3rd Gulf Research Meeting, Cambridge, UK, 11-14 July.
- 52. Mahgoub, O., & Kadim, I. T. (2012). Distribution of muscle in the Omani dromedary camel carcass. Paper presented at the Conference of Sustainability of Camel Population and Production, King Faisal University, Saudi Arabia, 17-20 December.
- 53. Manickavasagan, A. (2012). Update on whole grain consumption in India and Middle East regions. Paper presented at the Whole Grain Summit, Minneapolis, Minnesota, USA, 20-22 May.
- 54. Manickavasagan, A., & Al-Yahyai, R. (2012). Computer vision and digital image processing technology for quality assessment and management of agricultural products. Paper presented at the International Conference on Computational Intelligence and Information Technology-2012, Coimbatore, India, 2-3 March.
- 55. Manickavasagan, A., Al-Yahyai, R., & Essa, M. M. (2012). Computer vision technology for potential applications in date palm industry. Paper presented at the Fourth International Date Palm Conference (FIDPC, Abu Dhabi, UAE, 15-17 March.

- Manickavasagan, A., Al-Yahyai, R., & Gabriel, T. (2012). Classification of date varieties using statistical classifiers. Paper presented at the NABEC-CSBE Joint Meeting and Technical Conference, Orillia, ON, Canada, 15-18 July.
- 57. Mbaga, M. (2012). Evaluating Consumer Preferences for Value-Added Fish Products Attributes in Oman. Paper presented at the IFET 2012 Tanzania Conference on Visible Possibilities: The Economics of Sustainable Fisheries, Aquaculture and Seafood Trade, Dar-Es-Salaam, 16-20 July.
- Piontkovski, S., Al-Gheilani, H., & Claereboudt, M. R. (2012). Seasonal and interannual changes of physical-biological interactions in the western Arabian Sea. Paper presented at the 3rd International Conference ICBEC-2012, Bangkok, Thailand, 24-25 November.
- Prathapar, S. A., Khan, M., & Mbaga, M. (2012). The potential of transforming Salalah into Oman's vegetables basket. Paper presented at the Joint 3rd Gulf Research Meeting Cambridge, UK, 11-14 July.
- Rahman, M. S. (2012). Challenges in multi-hurdles food preservation and its stability. Paper presented at the Frontiers in Water Biophysics, Perugia, Italy, 23-26 September.
- Rahman, M. S., Al-Hakmani, H., Al-Alawi, A., & Al-Marhubi, I. (2012). Thermal characteristics of freeze-dried camel milk and its major components. Paper presented at the Frontiers in Water Biophysics Symposium, Perugia, Italy, 23-26 September.
- Rahman, M. S., & Guizani, N. (2012). Strategy to use water in food industry for minimizationn of waste. Paper presented at the Workshop on Sustainable Water Use for Food Security, SQU, Oman, 20-21 March.
- 63. Raiymbek, G., Faye, B., Konuspayeva, G., & Kadim, I. T. (2012). *Meat quality characteristics of Bactrian (Camelus bactrianus) camel meat quality in Kazakhstan.* Paper presented at the Conference of Sustainability of Camel Population and Production, King Faisal University, Saudi Arabia, 17-20 December.
- 64. Salehi, M., Kadim, I. T., Mahgoub, O., & Negahdari, S. (2012). Quality characteristics of hairy Cashmere goat skin and leather. Paper presented at the XI International Conference on Goats (ICG 2012), Gran Canaria, Spain, 23-27 September.
- 65. Sarma, Y. V. B. (2012). Long-term changes in seas surface temperature (SST) and response of the local weather and marine environment. Paper presented at the Challenger Conference for Marine Science 2012, Norwich, UK, 02-08 September 2012.
- Singh, V., Guizani, N., Rahman, M. S., & Essa, M. M. (2012). In-vitro antioxidant activities of Zizyphus Spina Christi fruits (red date) from Oman. Paper presented at the International Conference on Food and Nutrition Technology for Public Health (ICFNP-2012), IISMAAS., New Delhi, India., 4-5 May.

- 67. Tageldin, M. H. (2012). Pathologic features of theileriosis in indigenous sheep in the Sultanate of Oman. Paper presented at the 1st Regional Conference of the Society for Tropical Veterinary Medicine 2012, Thailand, 18-21 June.
- Thirumahal, M., Dobretsov, S., & Abed, R. M. M. (2012). Microbial communities in antifouling marine paints. Paper presented at the 16th International Congress on Marine Corrosion and Fouling, Seattle, USA, 24-28 June.
- 69. Waly, M. (2012). Physical activity and general nutritional knowledge assessment of College-aged students in Oman: a cross sectional study. Paper presented at the World International Conference on Scientific Education Research and Technology (WICSR) - The 2012 Annual Conference, Niagara Falls, Canada, 24-30 April.

#### **Posters**

- Al-Azri, A. (2012). Harmaful algal blooms in the coastal water of Oman: An emergin threat to marine communities. Poster presented at the 50th ECSA Conference: Today's Science for Tormorrow's Management, Venice, Italy, 03-07 June.
- Al-Busaidi, A. (2012). Climate change in Oman: current knowledge and way forward. Poster presented at the Planet Under Pressure 2012 Conference, London, UK, 26-29 March.
- Al-Maskari, A. (2012). Assessment of genetic diversity among Omani Basil landraces using RAPD markers. Poster presented at the Malaysia International Biological Symposium, Malaysia, 11-12 July.
- Al-Sadi, A. M., Al-Jabri, A., & Al-Mahmooli, I. H. (2012). Are date palms going to face a devastating disease in the near future? Poster presented at the Sultan Qaboos University 2012, Exhibition Hall, SQU, Oman.
- Al-Yahyai, R. (2012). Fruit quality attributes of Citrus aurantifolia infected with Witches' Broom Disease of Lime. Poster presented at the 2nd All Africa Horticulture Congress, South Africa, 14-21 January.
- Al-Yahyai, R., & Manickavasagan, A. (2012). Fruit quality of date palm: influencing factors and assessment methods. Poster presented at the 7th International Postharvest Symposium 2012, Malaysia, 25-29 June.
- Dobretsov, S. (2012). Extremely hypersaline isolates from microbial mats exhibit quorum sensing quenching and anti-microbial properties. Poster presented at the 14th International Symposium on Microbial Ecology, Copenhagen, Denmark, 18-23 August.
- 8. Guizani, N. (2012). Comparative analysis of total phenolics, flavonoid content and antioxidant profile of different date varieties (Phoenix dactylifera L.) from Sultanate of Oman. Poster presented at the

International Conference of Agricultural Engineering (CIGR-AgEng 2012), Valencia, Spain, 08-12 June.

- Mahgoub, O., Kadim, I. T., Al-Marzooqi, W., Al-Lawatia, S. M., & Al-Isaee, R. (2012). Effects of feeding whole date palm fruits on feed intake, growth performance and meat quality of Omani goats. Poster presented at the XI International Conference on Goats (ICG 2012), Gran Canaria, Spain. 23-27 September.
- Mothershaw, A., Nzeako, B., Al Kharousi, Z., El Hadi, S., & Rahman, M. S. (2012). Characteristics and antimicrobial activity of Omani frankincense. Poster presented at the Sultan Qaboos University Day 2012, Exhibition Hall, SQU, Oman.
- 11. Piontkovski, S. A., & Claereboudt, M. R. (2012). Arabian Sea is Getting Less Productive (?). Poster presented at the Sultan Qaboos University Day 2012, Exhibition Hall, SQU, Oman.
- Rahman, M. S., Al-Hakmani, H., Al-Alawi, A., & Al-Marhubi, I. (2012). *Thermal characteristics of freeze-dried camel milk and its major components.* Poster presented at the Frontiers in Water Biophysics Symposium, Perugia, Italy. 23-26 September.
- Raiymbek, G., Faye, B., Konuspayeva, G., & Kadim, I. T. (2012). pH measurement of six muscles of Bacterian camels (Camelus bacterianus) from Kazakhstan. Poster presented at the 3rd Conference of the International Society of Camelid Research and Development, Muscat, Sultanate of Oman. 29 January - 01 February 2012.
- Sarma, Y. V. B., & Govender, A. (2012). Regime shifts in sea surface temperature and its impact on the climate and marine environment of Oman. Poster presented at the Sultan Qaboos University Day 2012, Exhibition Hall, SQU, Oman.

#### Abstracts

- 1. Al-Adwani, S. R. (2012). Development of egg-yolk derived by IgY against Compylobacter jejuni colonization associated proteins for use in passive imunotherapy. Abstract presented at the 112th General Meeting of the American Society for Microbiology, San Francisco California, USA, 16-19 June.
- Al-Mulla, Y.A. (2012). Water conservation through controlled environment agriculture. In: Book of Abstracts, The Symposium on Environmental Problems in the Arab World: Meeting Challenges of Sustainable Development, SQU, Muscat, Oman, 26-28- February.
- Essa, M. (2012). Role of NAD, oxidative stress and energy metabolism in autism spectrum disorders. Abstract presented at the ASN 2012, Sydney, Australia, 07-09 November.
- 4. Essa, M. (2012). *Kynurenine pathway is activated in autism*. Abstract presented at the ASN 2012, Baltimore, USA, 02-07 March.
# Booklet

 Claereboudt, M.R. and Khan, A.J. Undergraduate and Postgraduate Degree Programs. College of Agricultural and Marine Sciences, SQU, Academic Year 2012-2013.

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