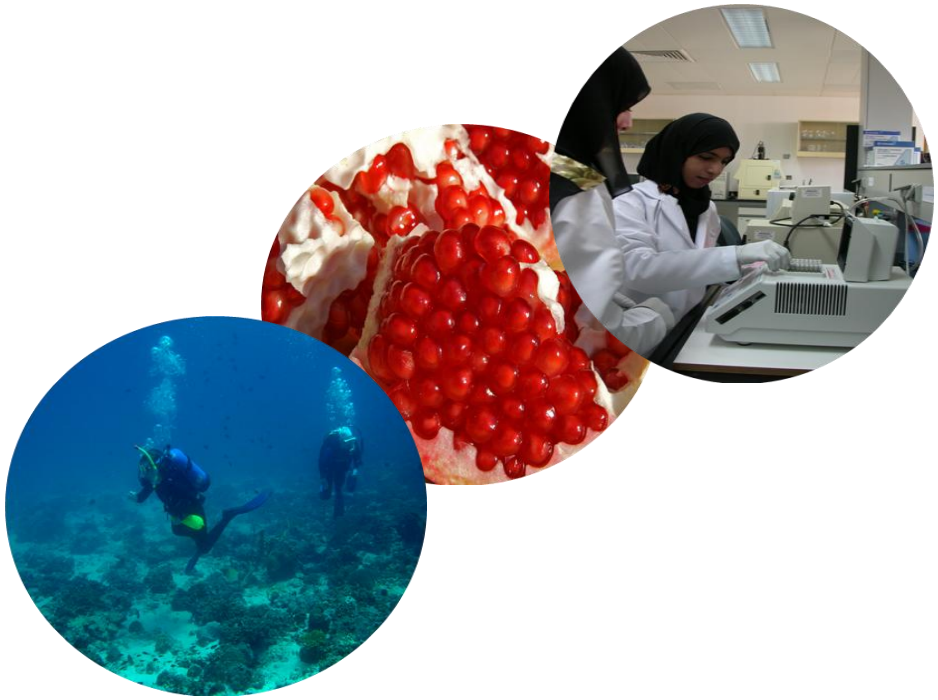
ANNUAL RESEARCH REPORT 2009



VOLUME XV

CAMS RESEARCH 2009

FACTS & FIGURES

- **RO 1,578,150 Total Budget**

- **55 Research Projects in Total**

    - **32 Internal Grant Projects (7 awarded in 2009)**

    - **10 Strategic Projects (1 awarded in 2009)**

    - **13 Externally-Funded Projects (4 awarded in 2009)**

- **69 Refereed Journal Publications**

Annual Research Report
2009

Volume XV

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Foreword

Research has always been an important aspect of academic life in the College of Agricultural and Marine Sciences. To support this increasingly important research effort, the College has invested in infrastructure, personnel and has continued to support faculty in obtaining internal and external sources of funding. CAMS research objectives falls under the umbrella of 3 main research themes: (1) food production, (2) food safety and security and (3) environmental sustainability with the long terms aims to (1) improve the efficiency and sustainability of animal and plant food production systems; (2) promote a sustainable use of terrestrial and marine natural resources; (3) develop a better understanding of the main ecosystems in times of local and global changes; (4) encourage healthier nutrition in both humans and animals.

In 2009, the total research budget at CAMS was 1,578,150 R.O. This includes one new funded HM project and 7 new projects funded from the University research funds. Because of the applied nature of some of the research carried out at CAMS, the transfer of knowledge, communication and extension of the research results to the end-users takes also a significant importance. This branch of our research activity is achieved through conferences, seminar, workshops and annual meetings with either the farmers or the fisherfolks.

The postgraduate programs in the College include both Masters and Doctoral programs. The Masters programs, initiated in 1997, keep attracting enthusiastic students in many fields of specialization (Animal and Veterinary Sciences, Crop Production, Crop Protection, Food Science and Nutrition, Marine Science and Fisheries, Natural Resource Economics, Soil and Water Management and Agricultural Engineering). In 2009, there were 105 students registered in the various MSc programs offered in Agricultural and Marine Sciences and 20 obtained their masteral degree during that year. By the end of 2009, 7 students were registered in newly established PhD programs; all involved in funded research projects.

The year 2009 was once again very successful in terms of research and graduate studies. I take the opportunity here to thank Dr. Mushtaque Ahmed whose contribution to this success, as Assistant Dean for Postgraduate Studies and Research during 2009, is hereby acknowledged. I would like also to thank both the Postgraduate and Research Committees of CAMS for their unwavering commitment to develop an environment conducive to excellence in research and postgraduate education. Finally, this success rests also partially on the shoulders of the Deputy Vice Chancellor for Postgraduate Studies and Research whom we sincerely thank.

Michel Claereboudt
Assistant Dean,
Postgraduate Studies and Research

Research Committee (2009)

Dr. Mushtaque Ahmed, *Chair*

Prof. Humphrey Esechie

Prof. Osman Gaafar

Dr. Ali Khalfan Al-Wahaibi

Dr. Majeed Al-Ani

Dr. Michel Claereboudt

Dr. Slim Zekri

Prof. Anvar Kacimov

The Year in Review

Introduction

Research in the College of Agricultural and Marine Sciences (CAMS) focuses on topics aiming at improving food productivity, safety and security from terrestrial and marine resources in an environmentally sustainable way. CAMS thus actively pursues basic and applied research that covers a broad range of disciplines in the areas of agriculture, horticulture, soil systems, water management, food systems, animal production, marine production, oceanography, aquaculture, marine ecology, etc.

CAMS research oriented culture which involves faculty, staff and, of course, not only graduate students but also undergraduate students, contributes to finding long term and scientifically sound solutions to some of the problems faced by the growing agricultural, fisheries and food sectors of the Sultanate's economy. It also contributes to a better understanding of both marine and terrestrial ecosystems through more fundamental research projects.

CAMS research achievements this year reflects this commitment of its faculty and staff to engage in research of strategic importance to the Sultanate and to mentor new generations of young scientists in the multiple fields of agricultural and marine sciences through a now well established Master program and the newly incepted Doctoral program.

Research Projects and Budgets

For the year 2009, the CAMS total research budget was RO 1,578,150, (Table 1).

Seven internal grant projects were awarded in 2009 (Table 2) (abstracts of internal grant research projects awarded in 2009 can be found on pages 41 to 47), while 16 were continuing (Table 3) and 9 internal grant projects were completed (Table 4).

Table 5 shows the strategic research project which was awarded in 2009 (abstract of this strategic research project is on page 49), while 6 other strategic projects were continuing (Table 6) and 3 were completed (Table 7).

In addition to the three externally-funded research awarded in 2009 (Table 8), another one was also awarded and completed in the same year (Table 9), while 5 were continuing (Table 10). Four externally-

funded research and development projects awarded from previous years and completed in 2009 are shown in Table 11.

Table 1. Summary of research and development projects held by the College over 2005-2009.

Source of Fund	Number of Projects	Budget (RO)*	Total Budget (RO)
Internally-funded (SQU) projects			**284,525**
Awarded in 2009	7	70,000	
Continuing	16	128,425	
Completed in 2009	9	86,100	
His Majesty's strategic research fund			**951,800**
Awarded in 2009	1	85,000	
Continuing	6	576,050	
Completed in 2009	3	290,750	
Externally-funded projects			**341,825**
Awarded in 2009	3	24,550	
Awarded in 2009 and completed in the same year	1	1,540	
Continuing	5	271,435	
Awarded from previous years and completed in 2009	4	44,300	
Total			**1,578,150**

Table 2. Internally-funded research and development projects awarded in 2009.

No.	Title of Research	Principal Investigator	Amount (RO)
1	Characterization of gummosis and foot/root rot diseases of citrus in Oman	*A. Al-Sa'di*	11,600
2	Causal agents of melon sudden decline in Oman	*M. Deadman*	10,000
3	Molecular characterization of Begomovirus associated with tomato and other crops and screening of tomato cultivars tolerant to tomato yellow leaf curl virus	*A. Jamal Khan*	10,000
4	The role of zooplankton in controlling the bloom-formation in Oman water bodies	*A. Al-Azri*	10,500
5	A database on the Arabian sea ecosystem	*S. Piontkovski*	11,000
6	Non-toxic antifouling compounds from marine bacteria	*S. Dobretsov*	12,000
7	Design and construction of greenhouses for arid regions: Phase 2	*Y. Al-Mulla*	4,900
Total			**70,000**

Table 3. Continuing internally-funded research and development projects.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Economic and institutional aspects of Kingfish management	2005	*H. Kotagama*	5,000
2	Nausea and vomiting in pregnancy, maternal nutrition and pregnancy outcome	2005	*B. Al-Rasasi*	3,600
3	Effect of manure amendment with varying C:N ratios on N mineralization in soil	2006	*S. Ismaily*	4,400
4	The effect of Omanization policy on the efficiency of dairy and date farms in Oman	2007	*M. Mbaga*	11,350
5	Molecular characterization of phytoplasma associated with Witches' Broom, phyllody/ virescence diseases of Sesame (*Sesamum indicum* L.) in Oman	2007	*A.J. Khan*	12,000
6	Application of water saving technologies in domestic water conservation in Oman	2007	*M. Ahmed*	4,900
7	Investigation of the prevalence of tick infestation and tick-borne haemoparasites of goats in the Sultanate of Oman	2007	*P. Bobade*	12,000
8	Reduction of post-harvest losses and improvement of fish handling systems in Oman	2007	*S. Al-Jufaili*	4,995
9	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
10	Evaluation of Omani camel performance under intensive management for meat production and quality	2008	*O.M. Gaafar*	12,000
11	Investigation on *Brucella melitensis* immunogenic domains	2008	*Y. ElTahir*	12,000
12	Damage cost in dry aflaj and live aflaj value for recreation	2008	*S. Zekri*	8,900
13	The taxonomy and ecology of *Benthic elasmobranchs* in the Gulf of Oman	2008	*A. Henderson*	4,980
14	Antiatherogenic characteristics of consumption of fruit and vegetables grown in Oman	2008	*M. Al-Ani*	11,000
15	Chemical and physical characterization of date pectin and its effect on Date syrup quality	2008	*A.A. Al-Alawi*	6,000
16	Production and quality assessment of a smoked tuna (*Thunus albacares*) product	2008	*N. Guizani*	3,800
Total				**128,425**

Table 4. Internally-funded research and development projects completed in 2009.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Development of salt and drought tolerant vegetable crops in Oman	2005	*A.J. Khan*	11,900
2	Biodiversity and community structure of hard-substrate littoral communities in the Sultanate of Oman	2005	*M. Claereboudt*	10,500
3	The effect of low levels of dietary cobalt on select parameters of the specific and non-specific immune responses of Omani goats	2006	*E. Johnson*	10,200
4	Bioavailability of iron in various types of meats in the Sultanate of Oman	2006	*I. Kadim*	10,000
5	Molecular investigation of lime Witches' Broom phytoplasma in Oman	2006	*N. Al-Saady*	10,200
6	Role of dietary and lifestyle risk factors on the prevalence of non-Hodkins lymphoma in Oman	2007	*A. Ali*	4,950
7	Biophysical dynamics of the upwelling ecosystems and surface currents along Oman	2007	*V.B.S. Yellepeddi*	12,000
8	The role of harmful algal blooms (HAB's) in the coastal water of Oman with emphasis on the role of *N. scintillans* and *Trichodesmium sp.*	2007	*A. Al-Azri*	12,000
9	Performance evaluation of a solar tunnel dryer for drying of fishes and dates in Oman	2008	*M.A. Basunia*	4,350
Total				**86,100**

His Majesty's Strategic Research Projects

Table 5. His Majesty's strategic-funded research projects awarded in 2009.

No.	Title of Research	Principal Investigator	Amount (RO)
1	Feasibility of managed aquifer recharge using excess treated wastewater in Oman	*M. Ahmed*	**85,000**

Table 6. Continuing projects funded through His Majesty's strategic research fund from 2006-2009.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Management of salt-affected soils and water for sustainable agriculture	2006	*S. Al-Rawahy*	95,000
2	Conservation and utilization of plant genetic resources in Oman	2007	*H. Esechie and N. Al-Saady*	139,300
3	Development of management strategies for pesticide resistance and pesticide residue problems in Omani agriculture	2007	*F. Talukder*	81,950
4	Rejuvenating lime and mango production in Oman: Resolving current challenges	2008	*R. Al-Yahyai*	100,000
5	Characterization, evaluation and conservation of indigenous animal genetic resources in the Sultanate of Oman	2008	*O. M. Gaafar*	80,000
6	Stock assessment of Kingfish	2008	*A. Govender*	79,800
Total				**576,050**

Table 7. His Majesty's strategic-funded research projects completed in 2009.

No.	Title of Research	Year Granted	Principal Investigator	Amount (RO)
1	Improving production of vegetable crops by develop-ment stress tolerant germplasm and farming systems research	2004	*F. Al-Said*	74,800
2	Value-added marine raw materials and health	2005	*B. Soussi*	150,000
3	Postharvest technology to reduce losses and improve quality and supply of Omani local fresh food produce	2005	*L. Opara*	65,950
Total				**290,750**

Externally-Funded Research Projects

The externally-funded research involved collaborations with Ministry of Agriculture, (MoA), Ministry of Fisheries Wealth (MFW), United Arab Emirates University (UAEU), International Islamic University, Malaysia (IIUM), Petroleum Development of Oman (PDO), Middle East Desalination Research Center (MEDRC) and other private institutions.

Table 8. Externally-funded research and development projects awarded in 2009.

No.	Title	Principal Investigator	Agency	Amount (RO)
1	Heavy metal contamination of fish and shellfish	*S. Goddard*	IIUM (Collaborative)	14,400
2	Histology training and consultation	*A. Ambu Ali*	MFW (Consultancy)	2,650
3	Detection of citrus exocortis viroid, citrus cachexia viroid and citrus greening bacteria by PCR assays in citrus trees from Royal Gardens and Farms	*A.J. Khan*	Royal Court Affairs (Consultancy)	7,500
Total				**24,550**

Table 9. Other externally-funded research and development project awarded in 2009 and completed in the same year.

No.	Title	Principal Investigator	Agency	Amount (RO)
1	Policy option for fish export to the GCC countries	*H. Boughanmi*	MFW (Consultancy)	**1,540**

Table 10. Continuing externally-funded research and development projects awarded from previous years.

No.	Title	Principal Investigator	Year Granted	Agency	Amount (RO)
1	Pesticide resistance and residue problems in Omani and UAE vegetable production. Phase II: Solution through rapid and molecular detection techniques & farmers awareness	*F. Talukder*	2006	UAEU (Collaborative)	24,750
2	Characterization of camel milk protein isolates as nuraceutical and functional ingredients	*A. Alawi*	2008	UAEU (Collaborative)	40,000
3	Jabal Akhdar rose water production projects	*M. Mbaga*	2008	MoA (Collaborative)	12,385
4	Assessment of shark population movements, delineations and breeding grounds in the Sultanate of Oman	*A. Henderson*	2008	MFW (Collaborative)	100,000
5	Diversity, stocks and feasibility of sea-cucumber aquaculture in Oman	*K. Al-Rashdi* *M. Claereboudt*	2008	MFW (Collaborative)	94,300
Total					**271,435**

Table 11. Other externally-funded research and development projects awarded from previous years and completed in 2009.

No.	Title	Principal Investigator	Year Granted	Agency	Amount (RO)
1	Assessment of PDO operated desalination and sewage treatment plants	*M. Ahmed*	2007	PDO (Consultancy)	7,700
2	Boron pre-treatment for seawater and brackish water desalination	*M. Ahmed*	2008	MEDRC (Consultancy)	5,740
3	Feasibility study to upgrade the effluent water treatment and water disposal system at the PDO MAF Terminal in Oman	*M. Ahmed*	2008	PDO (Consultancy)	16,320
4	Managed aquifer recharge of treated wastewater in Oman	*S.A. Prathapar*	2008	Oman Wastewater Services Co., SAOC (Consultancy)	14,540
Total					**44,300**

Other Significant Activities

University Research Day 2009

Some of the College's research projects were presented through oral and poster presentations. Abstracts of the projects presented can be found on pages 13 to 30.

ABSTRACTS

Oral & Poster Presentations

University Research Day
May 2, 2009

Oral Presentations

Diagnostic Investigation for Detection and Establishment of Prevalence of *Brucellosis* in Oman

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[2]The Veterinary Hospital, Ministry of Agriculture, Governorate of Dhofar, Salalah, Sultanate of Oman

In Oman, *brucellosis* is one of the major zoonotic diseases though mostly confined to the southern part of the country, namely, the Governorate of Dhofar. According to the Ministry of Health notified cases of brucellosis reached a peak between 1985 – 2004. The expanding animal reservoir, the emergence of *B. meltinesis* for which the efficacy of available vaccines has not been established and recent recognition of huge animal reservoir of *Brucella* in marine mammals with the potential virulence to livestock remaining unknown, necessitate diagnostic investigation for detection and establishment of prevalence of the disease.

The Sultanate is now a leading livestock producer in the Gulf region, with two millions head of cattle, goats, sheep and camels.

The present work is aimed at establishing the prevalence of *Brucella melitensis* in goats, cattle and camels in Dhofar area. Random blood samples were collected from goats, cattle and camels. All samples examined show only *Brucella melitenises*. Serum samples will be tested for their ability to bind extracellular matrix molecules (collagen, fibronectin, laminin and vitronectin) by the *brucellae*. The finding will offer new insights into understanding the interplay between *Brucella* and host cells.

Conservation and Utilization of Plant and Animal Genetic Resources in Oman

Humphrey Esechie[1], Nadiya Abubakar Al Saady[1], Akhtar Jamal Khan[1], Amanat Ali[2], Saleem Nadaf[3], Saffa Al-Farsi[3], Kadambot Siddique[4], Heather Clarke[4], Guijun Yan[5], Riyad Bayoumi[6], Saleh Al Hinai[3], Ali Al-Subhi[1] Yousif Al Maqbaly[1]

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The diversity of species, varieties and breeds is the basis for the development of highly productive crops and livestock. It also allows plants and animals to thrive in the face of harsh climatic conditions, pests or diseases. Conservation of indigenous plant germplasm is vital for the development of new and improvement of existing agricultural and medicinal plant species. Oman has abundant biodiversity in local grain, forage, horticultural, and medicinal plants that are adapted to the unique and diverse topographic and climatic conditions of the Sultanate. There is currently a decline in global biodiversity which threatens plant genetic diversity, the raw materials we rely on for food, fiber, medicine and industrial products. Several plant species have been extinct in Oman and some placed in the endangered species list. Also as in many developing countries, the Sultanate of Oman has introduced several modern crop varieties (bred and selected in other countries) into the research programs and released to farmers. This involves the replacement of the generally viable lower yielding local land races with introduced varieties, leading to genetic erosion of adapted land races.

To ensure that valuable genetic resources and indigenous knowledge are preserved this project aims to survey, identify, characterize and conserve indigenous crop and forage legume germplasm that are economically useful by incorporating molecular approaches. This will accelerate the utilization of Omani legume land races in the development of new varieties and or improve the productivity of the currently cultivated crop and forage legumes.

Antiatherogenic Characteristic of Consumption of Fruit and Vegetables Grown in Oman

Majeed R. Al-Ani[1], Linus U. Opara[1], Salam S. Al-Kindi[2], Fahad A. Al-Said[1]

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[2]College Medicine and Health Sciences,
Sultan Qaboos University, Muscat, Sultanate of Oman

Coronary heart disease (CHD) is the major contributor of morbidity and mortality in the world. The national health survey conducted in 1999 in Oman suggested that risk factors for cardiovascular disease are high and that coronary heart disease may be considered as the leading cause of death in the Sultanate, which may be attributed in part to dietary habit and practices. Antioxidant nutrients are believed to slow the progression of coronary heart disease because of their ability to inhibit damaging oxidative process. Among the antioxidant-rich foods are fruit and vegetables. Human and animal studies on several fruit and vegetables proved their cardioprotective effects, but no research has been conducted on products grown in Oman, since nutrient contents would vary with regional, seasonal, and ecological factors.

The aim of the present study was to investigate the role of consumption of certain fruit and vegetables grown in Oman, such as pomegranate in the prevention of CHD. Pomegranate has been shown in the literature to possess potent antioxidative capabilities against lipoprotein oxidation and platelet aggregation. Prior to the study, clearance from the University ethics committee was granted. The first phase of the experimentation involved analyzing pomegranate grown in Jabal Al-Akhdar for nutrient composition, with emphasis on the antioxidant content of the pomegranate juice (PJ) such as vitamin C, β-carotene, lycopene, and total antioxidants. In a preliminary study performed in summer of 2008, fourteen healthy female students from SQU campus took part in the study. All participants were in good health as determined by medical history questionnaire, physical examination, and laboratory blood tests. Before starting the experiment, 15 ml of overnight fasting blood samples were collected for analysis. Subjects were then given 200 ml of pomegranate juice per day for four weeks, except weekends. By the end of this period, blood samples were also collected. Analysis of blood included platelet aggregation, C-Reactive protein, lipid profile (triglycerides, total cholesterol, HDL, LDL, and VLDL), lycopene, β-carotene, vitamin C, total antioxidant status, and blood pressure. Results showed consistent maintenance of normal blood pressure, with a reduction in the level of blood cholesterol and triglycerides but increasing the level of HDL.

Two major human studies on the effects of pomegranate juice consumption on health in normal subjects, diabetic, and CHD patients are in preparation. These studies will lead to a better understanding of the interaction between fruit and vegetables consumption and the protection against CHD, using Omani grown produce.

Stock Status of *Epinephelus coioides* Harvested in Oman

Anesh Govender[1] and Jennifer McIlwain[2]

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Sultan Qaboos University, Sultanate of Oman,
[2]University of Guam

Status of the stock of *Epinephelus coioides* harvested in Oman was investigated by per-recruit analyses. Since the majority of fish harvested were female (few male, bisexual and transitional individuals) a combined von Bertalanffy growth curve was fitted to the age-length data yielding estimates of L_∞ = 1270.95mm, k=0.058yr^{-1} and t_0=-5.48yrs. Other per-recruit input parameters included the length-weight constants (a= 0.000005272 and b=3.13), age-at-capture = 1yr, age-at-maturity = 4yrs, an estimate of the natural mortality rate (based on the Pauly equation with temperature = 26.8 °C) equaled 0.096yr^{-1} and an estimate of the current fishing mortality rate of 0.36yr^{-1}. At the current fishing mortality rate the spawning biomass per recruit is predicted to be 5.5% when compared to an unfished state. A very conservative strategy of a target fishing mortality ($F_{0.2}$) can be achieved at fishing mortalities 0.12yr^{-1} (in terms of numbers of fish harvested) and 0.07yr^{-1} (in terms of weight harvested). Both strategies result in an increase of the spawner biomass per recruit to levels equal to 33% (in numbers) and 52% (weight) when compared to the pristine state.

The Effects of Regional Trade Agreements on Agri-Food Trade in the MENA Region: Evidence from a Gravity Model Applied to the GCC Countries

Houcine Boughanmi, Msafiri Mbaga, Hemesiri Kotagama

Department of Natural Resource Economics
College of Agricultural & Marine Sciences
Sultan Qaboos University, Sultanate of Oman

The last decade has witnessed a surge in Regional Trade Arrangements (RTA) among nations despite the increasing role of the World Trade Organization (WTO) in strengthening the multilateral trading system. This global phenomenon has also been witnessed in the Middle East and North African region (MENA) with the formation of new RTA's or the reinvigoration of the existing ones. The objective of this paper is to assess the trade performance of the GCC as a Regional Trade Arrangement and estimate the trade potential of GCC with countries or groups of countries with which a preferential trade agreement is signed or still in negotiation. The study used disaggregated data and estimated gravity equations for total exports, total agri-food exports and seven agri-food commodities according to the SITC classification, covering the period 1994-2004. Results indicated that the GCC as a regional trade arrangement has actually promoted trade integration significantly between the member countries in agri-food products as opposed to total aggregate trade. Trade integration is highest in dairy and dairy products where GCC intra-trade is 10 times more than what would be predicted by the basic model, followed by meat and meat preparations, fish and fish preparations, and cereal and cereal preparations. The GCC intra-trade did not seem however to change significantly over the years and had probably reached its full potential during the 93-96 period. The newly created GCC Custom Union is therefore promising in enhancing new opportunities of trade as it goes beyond the removal of tariffs to the elimination of non tariff barriers. Except with the Mashreq countries, trade of GCC with others regional groups and sub-groups is less than expected in all commodities suggesting that there is untapped trade potential which can be enhanced by negotiating a freer trade arrangements between these groups and the GCC region.

Evaluation of Microclimatological Parameters Inside a Screenhouse used in Arid Regions

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Previous studies on this type of protected agriculture showed that there is a need for a more detailed evaluation of the microclimatological parameters inside the screenhouse in addition to their influences on the planted crops, especially in arid region countries like Oman, and that was the main objective of this work. Where a Quonset screenhouse was equipped with 38 sensors during spring 2008 measuring solar radiation, relative humidity, air temperature, ground temperature, leaf temperature, wind speed and direction at different locations and heights inside the screenhouse.

The inside air temperature, with an average of 22.7°C, was uniformly distributed inside the screenhouse but it was slightly warmer than outside by 0.48°C. Upper leaf temperature was higher than the middle and lower part of the canopy during the midday (12:00 noon and 2:00 pm) whereas, lower temperature exceeds the upper temperature during the dawn time of the day. Relative humidity, with an average of 55.5 %, was also uniformly distributed inside the screenhouse and it was more humid than outside by 5 %. Although ambient wind speed was generally calm throughout the time of the study (ranges from 1.7 to 3.3 m/s), it did not exceed 0.46 m/s inside the screenhouse. Luna cucumber variety was planted inside the screenhouse in two soilless cultures, wood (WDS) and date palm (DPS) straws. The WDS planted cumber obtained a higher LAI than the DPS one. Maximum LAI of 3.47 for WDS cucumber was obtained in the middle of the screenhouse, while the DPS one obtained 2.24 at the same location. Although both WDS and DPS planted cucumber had the same average of height, the WDS one was taller than the DPS in a location towards the screenhouse door by 9.5 cm. while the DPS one was taller than the WDS towards the back side o the screenhouse by 16 cm. Moreover, WDS planted Luna cucumber variety produced 14% more yield and also 11% more number of fruits/plant than the DPS planted cucumber.

Poster Presentations

Pathological Features of *Caprine arthritis encephalitis* in Indigenous Goats

(SQU Project Code: IG/AGR/ANSC/05/02)

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[1]Departments of Animal and Veterinary Sciences, [2]Marine Science and Fisheries, College of Agricultural & Marine Sciences, Sultan Qaboos University, Sultanate of Oman

Caprine arthritis encephalitis virus (CAEV) is a chronic disease of goats characterized by inflammatory lesions in several organ systems including, brain, lungs, joints and mammary glands. The objectives of the study were to assess the pathologic changes and patterns of disease in the lung and associated lymph nodes of Omani goats.

Lungs and lymph nodes were collected at random from goats (6-36 months) slaughtered in Oman. Tissues were processed and stained with H&E and special stains. Among the 415 lungs and lymph nodes studied, 356 (85.78%) revealed lesions characterized by interstitial pneumonia associated with peribronchoilar, perivascular and or/ parenchymal lymphocytic infiltration or lymphoid nodules with or without germinal centers. The lymphoid follicles often compressed bronchiolar lumens. Dense fibrosis in the interstitial, interlobular, peribronchoilar and perivascular areas had been observed. The lymph nodes showed marked follicular and paracortical hyperplasia. None of the goats exhibited clinical signs or macroscopic lesions compatible with CAEV. The results suggest that Omani goats were exposed to *caprine arthritis encephalitis* virus and represent a subpopulation in the early phase of non-clinical phase of the disease. The histopathology of the disease in indigenous goats is different in certain aspects from those reported elsewhere.

Characterization of Fungal Pathogens Occurring in Potting Mixtures and Organic Fertilizers in Oman

(SQU Project Code: SR/AGR/PLNT/04/01)

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Potting mixtures, imported from overseas, as well as local and imported organic fertilizers are commonly used by growers in Oman for vegetable production. However, there is a lack of information about pathogens that might be introduced into farms along with potting mixtures and organic fertilizers. The purpose of this study was to investigate the most common fungal pathogens introduced into farms in Oman via potting mixtures and organic fertilizers. Forty-eight samples of potting mixtures and organic fertilizer samples were screened for their contamination with fungal pathogens using different methods. Fungal pathogens were identified using morphological characteristics and sequences of the internal transcribed spacer region of the ribosomal DNA (ITS rDNA). *Pennicillium, Rhizopus, Aspergillus, Helminthosporium, Alternaria, Trichoderma, Acrospira, Fusarium* spp and three human pathogens were isolated from potting mixtures and organic fertilizers. Investigating sensitivity of different *Fusarium* species to Hymexazole revealed high variation among isolates. Three isolates showed resistance to this fungicide. This appears to be the first report of the occurrence of resistance to hymexazole among *Fusarium* spp.

Rejuvenating Lime Production in Oman: Resolving Current Challenges

(SQU Project Code: SR/AGR/CROP/08/01)

Rashid Al Yahyai[1], Fahad Al-Said[1], Abdullah Al-Sadi[1], Michael Deadman[1], Ali Al-Wahaibi[1], Said Al-Ismaily[2], Malik Al-Wardy[2], Ahmed Al Bakry[3], Abdullah Al-Zidjali[3], Abdulrahman Al-Matrooshi[3], Ali Al-Lawati[3]

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Production of lime (*Citrus aurantifolia*) and other related citrus species in Oman have been significantly reduced in recent years. The reduction in yield has been attributed to a combination of abiotic and biotic factors that adversely affected tree growth and productivity. Loss of area cultivated with lime trees was 50% of that in 1990, mainly due to Witches' Broom Disease of Lime (WBDL). The disease that may have originated in the Sultanate has the potential to devastate lime production throughout the entire regions of western Asia and North Africa thus affecting fruit imports to Oman as well. In Oman, these problems have been worsened by increasingly stressful abiotic conditions caused by drought, salinity and soil infertility which ultimately led to the decline of fruit production in the country. The compound adverse effects of biotic and abiotic stresses on tree fruit yield have resulted loss of tree fruit acreage and profitability and reduced income from largely traditional farming systems. The unsustainable tree fruit production has eventually led to abandonment of many farms, to conversion of fruit farms to forage farms, or to complete change of the land use into other commercial projects. While the causal agent of WBDL (i.e. *candidatus* Phytoplasma aurantifolia) has long been identified, practical solutions to the disease have not been tested and these challenges remain many years later. Through national and international collaboration, methodological experimentation in the laboratory and field testing of efficient management strategies, this research will tackle solution-oriented aspects of WBDL in Oman. The researchers aim to eventually provide practical solutions to tree fruit growers, thus enabling them to continue production from diseased trees while new, long-term solutions through resistant cultivars are being gradually evaluated and introduced. The proposed project will address the phytoplasma-caused WBDL through molecularly identifying native citrus species for tolerance or resistance, characterizing the interaction of WBDL with other citrus diseases, continued breeding and hybridization of new *Citrus* resistant clones, establishment of field trials for evaluating hybridized and exotic cultivars of *Citrus*, particularly lime, study the on-farm alternative vectors and hosts and optimizing fruit production through management of diseased trees.

Characterization of Camel Milk Protein Isolates as Nutraceutical and Functional Ingredients

(SQU Project Code: CL/SQU/UAEU/08/01)

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Separation of camel milk proteins into well defined fractions will lead to a more optimal use of their high valued functional properties. The camel milk proteins as cow milk are constituted of caseins (major components), serum proteins or whey proteins, and the miscellaneous proteins.

Milk proteins are precursors of many different biologically active peptides. These peptides derived from the caseins and the whey proteins could be considered as dietary supplements in "functional" foods. Due to their beneficial functional properties, whey proteins are used as ingredients in many food products. However, there is little or no research on the functional properties of camel milk proteins. Since macroscopic properties are strongly related to the intimate structure of proteins, the protein conformational changes will be studied upon different conditions. These camel milk proteins are relatively poorly studied compared with cow's milk. The present investigation is to undertake studies to characterize various protein isolates of camel milk proteins (low molecular peptides, whey proteins) and to incorporate camel milk whey powder into food formulations such as ice cream formulation to play a role as fat replacer, flavour enhancer, texturizer, emulsifier and/or stabilizer. The study will also focus on the isolation, identification and characterization of the small molecular weight of the proteins and peptide fractions of camel milk proteins and relate their chemical structure with that of insulin which will ultimately put the basis for controlling diabetes by camel milk protein isolates.

In addition, the project will use camel milk to produce many added value products such as cheese, spray dried milk and condensed milk which will move the camel milk industry to a new avenue of exploitation.

Oceanic Eddies, Algal Blooms, and Fish Kills Along the Omani Coast

(*Funded by*: Agricultural & Fisheries Development Fund)

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Harmful algal blooms (HABs) are caused by phytoplankton species inhabiting coastal and oceanic waters. HABs are intensifying and spreading all over the world including the coastal waters of Oman. The harmful effects originate from poisoning of marine organisms by the biotoxins in algal cells, from clogging of fish gills by phytoplankton, and from mortality due to the anoxia mediated by the intensity of blooms on one hand and mesoscale physical variability on the other. Using remote sensing and monthly field sampling, we analyzed the development of HABs and fish kills along the Omani coast, from 1971 through 2008. The real time data available from the NASA satellites enabled us to monitor the origin, position, and movement of mesoscale eddies in the western Arabian Sea. The relationship between the structure of the eddy field and intensity of HABs was discussed.

Cost Evaluation of Desalination and Sewage Treatment Based on Plants Operated at Sites of Petroleum Development of Oman (PDO): A Case Study

(SQU Project Code: AS/AGR/SWAE/07/03)

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The performance of the desalination and sewage treatment plants operated by contractors at PDO sites were evaluated, in relation to benchmark costs. The benchmark costs of desalination and sewage treatment were established based on estimates provided in research literature and based on site specific estimates made using software models. The Desalination Economic Evaluation Program (DEEP) software produced by International Atomic Energy (IAEA, 2006) was used to estimate site specific cost of desalination and Financing for Environmental, Affordable, and Strategic Investments that bring on Large Scale Expenditure (FEASIBLE) software published by Danish Cooperation for Environment in Eastern Europe (DANCEE, 2004) was used to estimate site specific cost of sewage treatment. The PDO sites at Bhaja and Marmul were considered as representative cases for the estimation of cost of desalination and sewage treatment, respectively. The estimated site specific benchmark cost of desalination was 0.462 OR/Cu.M. The desalination cost reported in literature range between 0.200 OR/Cu.M.and 0.500 OR/Cu.M. PDO pays contractors 0.394 OR/Cu.M. for desalinated water produced at the site. The estimated site specific benchmark operational cost of sewage treatment up to BOD level of 10-15 mg/L of treated water was 0.113 OR/Cu.M. The cost of sewage water treatment, up to BOD level of 10-15 mg/L of treated water averages to 0.158 OR/Cu.M based on studies conducted internationally and the estimate quoted in Oman is 0.085 OR/Cu.M. The operational cost estimate on sewage treatment estimated by contractor technician at the Fahud PDO site was 0.100 OR/Cu.M. The comparison of costs reveal that the cost of desalination and sewage treatment at PDO sites were close to benchmark costs provided in research literature as well as site specific estimates made using software models.

Performance Evaluation of a Solar Tunnel Dryer for Drying Fishes and Dates in Oman

(SQU Project Code: IG/AGR/SWAE/08/01)

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The use of solar tunnel dryers in drying agricultural products has shown to be practical and economical. It considerably reduces the drying time compared to open air natural sun drying. Taking into consideration the fish harvesting capacities and the land–holding capacities of the marginalized rural farmers in Oman a 12 meter long and 2 meter width tunnel, with a collector area of 12 m^2 and a drying area of 12 m^2 was designed and constructed. The light weight aluminum frame is used as the upper structure of the half circle tunnel to support the transparent plastic sheet. The entire tunnel was placed about 700 mm from the ground surface on concrete blocks sub-structure. Solar radiation passes through the transparent cover and makes the air hot inside the air tight tunnel, particularly in the collector portion due to the presence of black surface flat collector. A solar powered fan (40 W) is used to force the hot air from the collector portion of the tunnel to the dryer portion over the product to be dried. No load test was conducted in July-August 2008. It was found that the ambient temperature can be easily raised to 45-60^oC inside the dryer, which was above 5-15^oC of the ambient air temperature while the average air flow rate was 15.-2 m/sec inside the tunnel. About 18 MJ/m^2 of solar energy was possible to harvest and trapped inside the collector of tunnel for the drying period of 10 hour per day. So it would be possible to harvest about 860 MJ of energy by using 12 m^2 collector if the drying period for date is consider 4 days (40 hours) to reduce the moisture content level from 43% to 22% wet-basis. It is estimated that if the drying efficiency of the dryer is considered only 30-35% and the energy requirement is 3.5 MJ in removing per kg of moisture from the product, then it would be possible to dry 280-300 kg of dates per batch in 4 days. The dryer will be tested during next harvest season (July-August) in this year.

Investigations into the Effectiveness of Cations, Fly-ash and Fruit-based Residues for the Removal of Boron from Seawater

(SQU Project Code: AS/AGR/SWAE/08/01)

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Due to its interaction with the environment, the boron concentration in both drinking water and wastewaters discarded to the environment is constrained by the WHO guidelines and EU regulations. Many desalination plants utilizing seawater have trouble in removing boron to the drinking water standards. The objective of this study is to carry out experimental investigations into the removal of boron from seawater using three methods including, adsorption by natural fruit seeds ash, adsorption by power plant fly ash and used coagulant. Various parameters have been tested including pH, reaction time, liquid/solid ratio (L/s ratio), effect of particle size and burning temperature. Results indicated that fruit seed based ash has higher removal efficiencies of boron (>70%) compared to the other materials tested with optimum conditions found to be around pH=7 and L/s=2. Removal efficiencies increased with decreasing particle size possibly due to the increase in contact surface area. Additionally, increasing dosage size also resulted in better removal efficiencies. The results from the present work (fruit seed ash) are considered to be of practical value and the techniques proposed for the removal of boron are effective due to membrane stability, low costs and lack of membrane scaling at ph=7 (low $CaCO_3$).

Management of Salt-Affected Soils and Water for Sustainable Agriculture

(SQU Project Code: SR/AGR/SWAE/06/01)

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Soil salinity is a serious threat to Omani agriculture and its economy. It also leads to desertification of landscapes. Most of the Al-Batinah soils are coarse textured and therefore have unimpeded drainage that reduces buildup of salts if properly managed. Appropriate solutions which are environmentally sustainable have been identified and promoted. Date palm leaves mulch on sorghum planted plots was more effective in conserving soil water content, reducing salt accumulation in the soil, reducing soil temperature and resulting in higher yield of sorghum compared to the plastic mulch and the control. Three of the five new varieties of pearl millet did very well and with good yield even with salinity with very high salinity of 9 dS/m. Tomatoes showed good salt tolerance even at high and very high salinity. Feeding Omani sheep with sorghum grown at high and very high salinity did not adversely affect their health and their meat quality. Results regarding the current impact of salinity at Al Batinah have been achieved through a survey of 61 farms. More farms are being surveyed. Integrating fish culture with saline agriculture is still in progress.

Great Tomatoes Despite Salinity

(SQU Project Code: SR/AGR/SWAE/06/01)

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Growing crops using saline irrigation water in conditions where soil has low nitrogen and other essential nutrient contents is of great importance. This is vital and challenging task & especially critical for environmentally sound, sustainable agricultural production. The objectives of this work were: (1) to examine the yield and quality of tomato (*Lycopersicon esculentum* L.) grown using various levels of saline water; and (2) to study the effect of different types of fertilizers on the yield and fruit quality of tomatoes grown under saline conditions. An experimental plot was set up at the Agricultural Research Station, Rumais, Oman, to study the effects of salinity and fertilizer on tomato production. Tomatoes were grown in sandy soil and irrigated with three levels of saline water (EC_w = 3, 6 and 9 $dS.m^{-1}$). Three types of fertilizer treatments were applied including: inorganic NPK, organic [cow manure] fertilizer, and a mixed fertilizer of both. Tomato seedlings were planted during the months from Nov. to April and for two consecutive seasons. A two-factor completely randomized design was used for this experiment. Total fruit number and weight of harvested tomatoes were determined. Fruit quality attributes including total soluble solids (TSS), EC, pH, and biomass was also measured. Results indicated that growing tomatoes under 3 and 6 $dS.m^{-1}$ irrigation water produced the highest yield whereas irrigating with 9 $dS.m^{-1}$ significantly reduced the final fruit number and fruit weight. Tomato yield was lowest in plants fertilized with cow manure compared to those fertilized with inorganic and mixed fertilizers. Measured fruit quality attributes were not significantly affected by salinity or fertilizer treatments. The data suggests that the best growing conditions for tomatoes are irrigation with 6 $dS.m^{-1}$ and fertilization with mixed fertilizer that contained both cow manure and inorganic NPK.

Antimicrobial Activity of Soft Coral Extracts from Bandar Al-Khayran in Sultanate of Oman

(SQU Project Code: SR/AGR/FOOD/05/01)

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Several species of soft corals from Bandar Al-Khayran, Sultanate of Oman were investigated for bioactive marine natural product. The extracts were screened against marine biofilm and various strains of pathogenic bacteria. Several extracts were shown to have bioactivity against pathogenic bacteria such as *Micrococcus* sp., *Staphylococcus* sp., *Bacillus* sp., *Salmonella* sp., *E. coli,* and *Pseudomonas* sp. The ethyl acetate extract from *Cladiella* sp. was found as a source of potential antifouling compounds as it inhibited the growth of marine biofilm bacteria *Bacillus sp.* Bioassay guided fractionation was performed using silica gel, polyamide, reverse-phase and thin layer chromatography. Bioactive compounds were isolated and characterized using advanced ID, 2 D NMR and LC MS-MS techniques. One of these bioactive compounds is hydroxytritriacontanoic fatty acid.

Screening and *in vitro* testing is on-going.

Significant Research Outcomes

Significant Research Outcomes

Department of Food Science and Nutrition

Food Stability Beyond Water Activity and Glass Transition: Macro-Micro Region Concept in the State Diagram

Mohd Shafiur Rahman

The water activity concept proposed that a food product is most stable at its monolayer moisture content. Recently the limitations of the water activity concept were identified and the glass transition concept was proposed in order to overcome the limitations of water activity. Based on the glass transition concept, a food is the most stable at and below its glass transition point. Recently it has also become evident that the glass transition concept is not universally valid for stability determination when foods are stored under different conditions. The glass transition concept was used to develop the state diagram by drawing another stability map using freezing curve and glass line. It is being emphasized in the literature to combine the water activity and glass transition concepts. An attempt was made to combine these two concepts in the state diagram and to propose a macro-micro region concept for determining the stability of foods. The proposed concept was tested to determine the oxidation of fats in dried fish during storage and stability of allicin (a health functional component) in garlic during drying by different methods.

Dietary and Lifestyle Factors and Risk of Non-Hodgkin's Lymphoma in Oman

Amanat Ali

A case control study was conducted to evaluate the associations between dietary and lifestyle factors and risk of non-Hodgkin's lymphoma (NHL) in Oman. Forty three histologically confirmed NHL cases diagnosed at Sultan Qaboos University Hospital (SQUH) and Royal Hospital, Muscat, Oman and the same numbers of their age matched population based controls were used in this study. Dietary intake information was collected using a 117-item semi-quantitative food frequency questionnaire (FFQ). A non-significant increase in the risk of NHL was observed with higher body mass index (BMI) (OR= 1.20, 95% CI: 0.45, 2.93), whereas a significantly decreased NHL risk was observed with higher educational level of respondents (OR= 0.12, 95% CI: 0.03, 0.53). When the highest quartile of intake was compared with the lowest, a

significantly increased risk was observed for higher intake of energy (OR= 2.67, 95% CI: 0.94, 7.57), protein (OR= 1.49, 95% CI: 0.54, 4.10) and carbohydrate (OR= 5.32, 95% CI: 1.78, 15.86). Higher consumption of daily servings from cereals (OR= 3.25, 95% CI: 0.87, 12.09) and meat groups (OR= 1.55, 95% CI: 0.58, 4.15) were found to be associated with NHL risk, whereas a significantly reduced risk was associated with higher consumption of vegetables (OR= 0.24, 95% CI: 0.07, 0.82). The consumption of fruits and milk however did not show any significant association with NHL risk. No apparent association was observed between the fat intake and percentage contribution of energy from various macronutrients with NHL risk. Overall, the results of the present study suggest that diet has an association with NHL risk. However, further investigations with larger number of subject are required to confirm these findings.

Department of Natural Resource Economics

The Preparation of a Code of Practice for Financing Investment in the Small-Scale Fisheries Sector

Andrew Palfreman

This is a study undertaken in collaboration with Fishtech Management Consultants for the Ministry of Fisheries Wealth, completed in February 2009.

The research identified that the majority of the formal credit obtained by fishermen is from the Oman Development Bank (ODB). This is undoubtedly because of the preferential interest rate charged - 0% below RO 5,000 and 3% above (with 6% subsidy provided by the State). In 2007 the average loan from the ODB for the fisheries sector was only RO 3,157. Most fishermen requiring small loans (<RO 5,000) are happy with the way ODB operate – the main concerns identified in the research largely related to loans for larger vessels and loans specifically for youth who lack any form of collateral, savings, bank account or credit history, and who are therefore unable to access credit from the ODB or commercial banks. The study presented a number of fishermen's credit models from other countries and made recommendations for the improvement of the Omani system, especially its application to young fishermen without collateral. The research also resulted in the preparation of a draft code of practice for the supply of credit to the fisheries sector, advocating greater flexibility, alignment with government policies towards the sector and closer integration with the commercial and biological characteristics of the fishery.

The Potential Economic Loss to the Oman Economy as a Result of Exporting Unprocessed Fish

Msafiri D. Mbaga, Saud M. Al-Jufaily and Mariam M.S. Al Belushi

This study is an attempt to estimate the potential loss in economic activity to the Oman economy as a result of exporting unprocessed fish. Because of the lack of input output data on the Oman fisheries needed to compute the necessary multipliers, this study had to use estimated fish processing multipliers available from other sources. Results show that if the fish exported between 2003 and 2007 was to have been processed in Oman between 479.7 to 829.5 million RO in total economic activity could have been generated. Furthermore, between 2003 and 2007 if all the unprocessed fish exported had been processed in Oman, that could have generated between 0.874 and 1.818 billion RO increase in income, as well as, additional income of between 0.65 and 1.594 billion RO through induced effects. Results also show that for every person the fish processing industries could have employed (if all fish processing was to be done in Oman) between 3 to 5 jobs could have been created in the other sectors of the Oman economy. These results however, must be taken only as broad indicators because of the lack of input and output data in Oman. It was also found that fish prices between markets in Oman and between Oman and export markets, notably Dubai Central Market continue to diverge from the Law of One Price. In addition to the lack of efficient market information, structural and institutional aspects of these markets also prevent prices from reflecting the true cost of fish transactions.

Damage Cost in Dry Aflaj and Live Aflaj Value for Recreation (IG/AGR/ECON/08/01)

Slim Zekri

Two research outcomes of this project are worth mentioning -

1. **Contribution of the agricultural sector to tourism and recreation**: Agriculture provides a flow of amenities in the desert environment which are not accounted nor paid for. We estimated the recreation use value of "Misfat Al-Abryeen" oasis which is assimilated to a man-planted forest. The travel cost method was used through an on-site questionnaire. The average Consumer Surplus or benefit from visiting "Misfat Al-Abryeen" is estimated at US$ 123 per individual per trip. The total social benefit from this oasis is estimated at $ 222,300 per year. Results show the role played by irrigated agriculture in the provision of amenity services for the tourism sector. The sustainability of the irrigation activity depends on the recognition of the recreation role of oases and the transfer of part of these benefits to the farmers who are managing the irrigation system.

2. **Estimating the damage cost of "dead" Aflaj**: More than 1,000 Falaj were declared "dead" since 1996. We estimated the agricultural income losses due to Aflaj dry-up, the household and life conditions degradation as well as the land value changes. Thirty three dead Falaj were visited and 205 farmers were interviewed. The average income loss per farmer was estimated at 2,833 Rials/year. Around 19% of the full time farmers were unable to find new jobs after drying up. Sixteen per cent of the families were obliged to relocate to another house due to water dry-up. On average the loss per family was estimated to 31,813 Rials. Besides on average every family is spending an extra 328 Rials on drinking water after the falaj dry-up and an extra 551 Rilas to buy vegetables and fruits which were previously produced at farm level. On the other hand some farmers have benefited from land value increases due to their changes into urban land. Finally, the total present value of losses due to aflaj dry-up is estimated at 48,000 Rials/family. This study shows the importance of protecting aflaj from an economic and social point of view.

Department of Soils, Water and Agricultural Engineering

- Strategy of co-existing and adjusting to saline soil and groundwater environments in the Omani agricultural sector has been developed with field studies of different crops and irrigation norms, collateral benefits for livestock and aquaculture, laboratory studies of different salt tolerant crops, numerous workshops and extension meetings with Omani farmers, which included two-way teaching on physical, chemical, agronomical, social, economic and other aspects of salinity in agriculture.

- A strategic project on artificial groundwater recharge by tertiary treated water has been launched. After pilot studies and consultancy projects with the Omani wastewater treatment company a fundamental understanding of hydrogeology, hydrology and hydrogeochemistry of potential disposal sites on the Batinah coast is attained and several technologies of injection-abstraction are evaluated.

- A special volume "Applying Mathematics to Flow in Porous Media" of a Springer "Journal of Engineering Mathematics" has been edited jointly with Prof. Strack (University of Minnesota, USA).

Department of Animal and Veterinary Sciences

- Professor Eugene H. Johnson's Veterinary Research Lab made the discovery that the polymorph nuclear leukocytes of newborn lambs exhibit a significantly lower oxidative respiratory burst than those from their dams. The findings, recently published, help shed additional light on why neonatal animals have such a high proclivity towards infectious diseases during the first weeks after birth.
- Research done in the Veterinary Research Lab also provided definitive proof that vitamin B12 deficiency leads to reduction in reactive oxygen species generation in the phagocytic cells of patients and therefore had a severe effect on the non-specific immune system.

- Research done at Dr. Isam Kadim's Meat Lab showed that some of the meat sold in Oman is contaminated with melamine, which causes kidney diseases in human. The research also showed that cooking meat at high temperature (above 100 degree centigrade) converts the heme iron into non-heme iron in various types of meats.

Department of Marine Science and Fisheries

A Database on the Arabian Sea Ecosystem
(IG/AGR/FISH/09/02)

Sergey Piontkovski

A multilateral data from over 10 international expeditions to the western Arabian Sea, along with the SQU coastal sampling and remotely sensed data (from the MODIS satellite) will be used, to assemble the database. The data set includes 1000's of vertical profiles and samples of various oceanographic variables. Biological data on phytoplankton, zooplankton and other biota are also included.

Assessments of Mesoscale Physical-Biological Interactions Along the Coast of Oman as the Basis for Understanding the Periodic Fisheries Losses (Fisheries Development Fund Project)

Adnan Al-Azri (PI), Sergey Piontkovski (Co-PI)

The harmful algal blooms (HABs) and the oxygen depletion are believed to be the major causes of periodic massive fish kills along the Omani coast. HABs in the coastal waters of Oman have been documented for nearly three decades. As the blooms lead to massive fish kills, there is an urgent need to understand the physical-biological coupling underlying its development and to take appropriate measures for the mitigation of fisheries losses. The project is aimed to quantify the mesoscale physical variability (with a special reference to oceanic eddies), the oxygen depletion periods, and annual variability in fish kills in the Sea of Oman. An impact of HABs on bacterioplankton (as a food of zooplankton and a source of toxins), zooplankton (as the food resource for fish) and fish populations will be analyzed. Series of peer-reviewed papers, conference presentations, and a website synthesizing project results will be done.

We have been analyzing paralytic shellfish poisoning toxins (PSP) in water samples and dead fishes (sardines) during algal bloom of *Cochlodinium polykrikoides*. The presence of PSP toxins was investigated by both mouse bioassay and instrumental technique based on high performance chromatography (HPLC). We were unable to find the PSP toxins in water and fish samples. Nevertheless, buthanol extracts of fish showed high toxicity both in *Artemia salina* and mouse bioassays. This suggests the presence of other toxins still to be identified and monitored during algal blooms.

Non-Toxic Antifouling Compounds from Marine Bacteria (IG/AGR/FISH/09/03)

Sergey V. Dobretsov

From samples of microbial communities from hot springs (Al Ansab, Ghala, Boshar, Nakhl and Rustaq) and from the surface of marine organisms (sponges, soft corals, tunicates and algae). We isolated 20 pure cultures of bacteria and Archaea, as well as 80 consortia of cyanobacteria with heterotrophic bacteria. These strainsand consortia are kept in culture or in stock at -80^0 C. We are now in the process of identification of these strains. Additionally, we isolated DNA from the hot springs microbial communities and amplified it by

polymerase chain reaction (PCR) using specific primers. The amplicons was applied to multiwell plates and sequenced. Methanol extracts of microbial communities from hot springs were filtered and concentrated Most of the extracts inhibited growth of *Micrococcus luteus*, while the growth of other 6 pathogenic bacteria was less affected. Only the extracts from Nakhal biofilms inhibited the growth of marine biofouling bacteria. Most of the extracts blocked quorum sensing (QS) activity of the biosensor strains *Chromobacterium violaceum* CV17 and *Agrobacterium tumefaciens*, while only water soluble compounds from Al Ansab and Nakhl biofilms inhibited QS of *Salmonella enterica*. None of tested extracts inhibited biofilm formation of *P. aeruginosa*. Toxicity of the extracts was evaluated using the brine shrimp nauplia bioassay and suggest overall low toxicity. Both polar and non-polar compounds from Nakhl biofilms inhibited settlement and growth of the biofouling diatom *Amphora cofeaeformis*.

Stock Assessment of Kingfish

Anesh Govender

Results indicate that the fishery is experiencing an even higher fishing mortality than in previous years. Moreover, estimates of fish age indicate that the majority of kingfish sampled so far are between the ages of 0 and 1 year; indicating a drastic reduction in the mean age of kingfish harvested. These ages also represent a significant proportion of juvenile (not mature) fish being harvested.

From this project two significant MSc theses have been produced. Mr Abdullah Hilal Al-Balushi has developed a kingfish management plan for Oman. He has found strong acceptance of the plan from fishermen and fisheries managers in Oman; and more importantly from other GCC countries. Furthermore, we have also developed a model that estimates the optimal number of kingfish to be sampled annually, in order to obtain robust growth parameters and age data. The model predicts that annual sampling can be reduced from 900 to around 600 fish per year. This represents a significant saving, not only financially but in terms of human resources to process the biological data.

Antioxidant Properties of Fish Muscle

Bassam Soussi

It has long been known that omega 3-fatty acids from fish have beneficial health effects. In a series of studies, we have however, focused on the fish muscle and aqueous phase (press juice, PJ) instead of the lipid phase. The hypothesis of antioxidative protection of the PJ from various fish species was tested in vitro, in cell model systems and in vivo, in mice models of cardiovascular disease.

The results demonstrate that the PJ have strong antioxidative effect. Most striking, in the mouse model, cardioprotective effect and increased survival were demonstrated. This finding will shed further light on the mechanisms behind the beneficial health effects of fish. (Link: http://www.saworldview.com/article/changing-perceptions).

Summary of Internal Grant Projects Awarded in 2009

Characterization of Gummosis and Foot/Root Rot Diseases of Citrus in Oman

A. Al-Sa'di, P.I.

Duration: 3 years **Budget:** 11,600

Summary

Several citrus species have long been observed to show gummosis and foot/root rot symptoms in different regions in Oman. Where this occurs, it is usually followed by death of the whole tree. No studies have been undertaken to investigate the nature of the problem. This raises concerns about a sudden outbreak of a new disease that may result in the next disaster for citrus growers in Oman following the destruction of their lime trees by witches' broom disease of lime. Due to the need for immediate action to understand the nature of this problem, this proposal, through collaborations between researchers from SQU, Ministry of Agriculture, Royal Gardens and Farms and leading international institutions, aims at investigating the occurrence, distribution, pathogenicity and sensitivity to fungicides of pathogens associated with death of citrus trees in Oman. The occurrence of the disease in Oman will be mapped in order to find out the most seriously affected areas. Characterization will be achieved using morphological characteristics as well as molecular tools. Pathogenicity trials will be conducted on citrus seedlings and studies will also be on factors enhancing the disease and means of spread of the causal agents.

Causal Agents of Melon Sudden Decline in Oman

M. Deadman, P.I.

Duration: 3 years **Budget:** 10,000

Summary

Melon sudden decline is arguably the most important threat to annual crop production in Oman. Losses by individual growers have been as high as RO60,000 per year. Despite its seriousness, concerted action to resolve the problem has not been undertaken. Indeed, although preliminary research has been conducted into lessening the impact in terms of grower losses, basic research into causal agents has not been completed. Melon sudden decline is characterized by the complete collapse of the crop approximately 50 days after planting, immediately prior to harvest and leading to total yield loss. Despite being a disease of international importance, world-wide there is little consistency in reported causal agent identification. The proposed research will resolve the issue of the causal agent of melon sudden decline in Oman. Sites with a history of the disease will be identified; crops and soils will be sampled and analysed for the presence of pathogenic micro-organisms. Isolated pathogens will be characterized by traditional and molecular techniques. Crop growing conditions will be adjusted to lessen the economic impact of the disease. Epidemiological studies will evaluate the spatial and temporal dynamics of disease progress.

Molecular Characterization of Begomovirus Associated with Tomato and other Crops and Screening of Tomato Cultivars Tolerant to Tomato Yellow Leaf Curl Virus

A. Jamal Khan, P.I.

Duration: 3 years **Budget:** 10,000

Summary

Whitefly-transmitted geminiviruses are currently the main biotic constraint to tomato production in Oman and many other countries in the tropical and subtropical regions of the world. In an attempt to control this insect vector producers are using increasing amounts of pesticides, which pose a threat to health and environment, and there has been little benefit from their use and abuse. Resistance of the whitefly to the newer and most effective insecticides seems to be occurring, as evidenced by recent increases in the whitefly populations in some parts of Oman. Producers have responded by increasing their levels of applied technology, using more chemicals and buying virus-free seedlings. Production costs have therefore increased, yet crop yields have gone down. The use of genetic resistance in integrated pest management is an alternative, which has not been utilized in Oman in the development of strategies for the control of the whitefly-geminivirus complex. This project offers a unique opportunity to apply technology from diverse fields, virology, molecular biology, and genetics in the solution of a pressing agricultural problem in Oman and to provide additional tools towards the development of sustainable production systems in the country. We propose to undertake a detail survey of tomato grown in Oman and characterize the begomoviruses and DNA-ß using molecular tools. Screening of tomato germplasms by *Agrobacterium* infectious clone will help in selection of TYLCV tolerant cultivars.

The Role of Zooplankton in Controlling the Bloom-formation in Oman Water Bodies

A. Al-Azri, P.I.

Duration: 3 years **Budget:** 10.500

Summary

Onset of coastal upwelling off the Arabian Peninsula presents persistent physical and chemical conditions (sufficient nutrients, stability, seed populations, iron, physiological readiness) that should support a high biomass bloom of phototrophs (diatoms and cyanobacteria); however, such a bloom does not occur. Our hypothesis is that diapausing copepods and other types of zooplanktons present in water being upwelled prevent a bloom from developing during the early SW Monsoon by directly feeding on diatoms and cyanobacteria to obtain the carbon and nitrogen (via cyanobacterial nitrogen fixation) needed for their metabolism. An important consequence of such top-down control of phototrophs abundance would be that major carbon and nitrogen export from the surface layer is shifted offshore of the coastal upwelling area. These conditions are in stark contrast with other upwelling areas where diatom and cyanobacterial growth and zooplankton (copepod) feeding are uncoupled at the onset of upwelling, and at the boundaries of the upwelling area, leading to massive blooms that support large clupeid fisheries within tens of kilometers of the coast. In the proposed work, we will study the grazing activity of zooplankton species on bloom phototrophic organisms (diatoms and cyanobacteria) and the influence of this interaction on the occurrence of large blooms.

A Database on the Arabian Sea Ecosystem

S. Piontkovski, PI.

Duration: 3 years **Budget:** 11,000

Summary

The Arabian Sea possesses one of the thickest oxygen-depleted layer known anywhere in the World Ocean. In some cases, winds and currents push this layer to upwell to the surface. This indirectly leads to unpredictable mass fish kills along the Omani coast. The physical-biological mechanism linking water dynamics with these fish kills is unknown however. The proposal sets up the basis for the analysis of this mechanism through the compilation of an oceanographical database, and the analysis of the physical-biological interactions between oceanic and coastal waters. A multilateral data from 10 international expeditions to the Arabian Sea, the SQU coastal surveys, and data from the MODIS satellite will be used. As well, the proposal facilitates the ongoing coastal sampling and taxonomical sample processing. The expected results will be presented in the form of the CD-mounted database (disseminated among the SQU faculty, graduate students, Omani Ministry of Fisheries, and the MS students), series of scientific papers, outreach activities, and the SQU course materials.

Non-toxic Antifouling Compounds from Marine Bacteria

S. Dobretsov, P.I.

Duration: 3 years **Budget:** 12,000

Summary

Marine biofouling (undesirable growth of organisms on man-made surfaces) causes enormous problems in the maintenance of pipelines, mariculture and desalinization plants worldwide and in Oman, in particular. Biofouling is currently controlled by the application of toxic antifouling compounds, which have dangerous impacts on the marine environment and on human health. Although marine bacteria are rich in bioactive compounds that might have applications in medicine, biotechnology and industry, very few investigations dealt with their antifouling compounds. In this study, we aim at isolating and characterizing antifouling compounds from Omani marine bacteria. Two different, but complementary approaches, will be used; a traditional one at the species (isolate) level and a novel approach at the microbial community level. In the former approach, marine bacteria will be isolated and screened for the production of biofouling compounds whereas in the novel approach the production of biofouling compounds will be checked under *in situ* conditions using whole microbial communities. Some of bioactive compounds are only produced by multispecies microbial communities under field conditions, which are difficult to mimic in the laboratory. The proposed research will enable us to explore the marine resources in Oman, train SQU students and discover novel bacterial strains and non-toxic antifouling compounds.

Design and Construction of Greenhouses for Arid Regions: Phase 2

Y. Al-Mulla, P.I.

Duration: 3 years **Budget:** 4,900

Summary

Modifications on the design of greenhouses used currently in Oman will take place in this project and these modifications will be used to construct new greenhouses. The new design will take into account the environmental and climatic conditions of arid regions and especially Oman for the purpose of improving the performance of the greenhouses to produce a better quality and high yields of different crops grown in these greenhouses.

Summary of Strategic Research Project Awarded in 2009

Feasibility of Managed Aquifer Recharge Using Excess Treated Wastewater in Oman

M. Ahmed, P.I.

Duration: 3 years **Budget:** 85,000

Summary

Managed Aquifer Recharge (MAR) is practiced widely to store water during periods of surpluses and withdraw during deficits from an aquifer. Aquifers are very good means of storing water. Since the water is stored below the ground, there are no evaporation losses. With reasonable care the water is protected from pollution. It uses minimum land area and causes no environmental damage. On the other hand, MAR has some disadvantages. In most cases, only a part of the recharged water is recovered in the short run. Quality of recharging water could lead to changes in physical and chemical characteristics of the soil and aquifer. Use of MAR with treated wastewater is being incorporated in several countries as part of overall water resources management. Currently groundwater recharge in Oman is practiced using recharge dams only. Similarly use of treated wastewater for irrigation is commonly practiced. It is thus likely that given proper regulatory framework, MAR with treated wasterwater is likely to become one of the acceptable water resources management strategies for Muscat region. Considering the anticipated wastewater production and the likely need for recharge, there is a need i) to monitor and ensure that the treated wastewater produced at the different plants meets quality constraints of recharge water, ii) to evaluate the hydrogeology in the vicinity of treatment plants and determine their aquifer potential for storage and iii) to evaluate recharge techniques and identify suitable methods for recharge and recovery given the soil and aquifer characteristics. The broader objective of this study would be to conduct a socio-economic and technical feasibility of MAR schemes in Oman especially in the Muscat areas using tertiary treated wastewater.

Graduate Program

Graduate Program

Below are the abstracts of thesis of 2009 PhD students while the various abstracts of the thesis work done by MSc students who graduated in 2009 are presented on pages 54 to 77.

Structural Characterization of Gelatin Extracted from Shaari Skin

Name of Student: Ghalib Al-Saidi
Supervisor: Prof. Shafiur Rahman

Gelatin is a biopolymer that has very broad applications in the food, pharmaceutical and photographic industries. In recent years however, fish gelatin has gained importance as the demand for non-bovine and non-porcine gelatin are increasing due to the bovine spongiform encephalopathy (BSE) crisis and for religious and social reasons. In addition, fish skin is a major by-product of the fish-processing industry, causing wastage and pollution. This waste could be used to develop the value added by-products and it could contribute to solve the problem of waste disposal. The main objective of this research is to develop the process of preparing gelatin from fish skin which will have comparable characteristics to the gelatin from mammalian sources. The extracted gelatin will be characterized based on their chemical, structural, and thermal properties measured by Differential Scanning Calorimetry (DSC), Fourier Transformed Infrared (FTIR) analysis and water vapor sorption. The local fish industry could use the developed technology to produce fish skin gelatin from their waste and they could market the ingredient for the food and pharmaceutical industry.

Isolation and Characterization of Antioxidant Activity from Date Varieties (*Phoenix dactylifera* L.) and Nabag (*Zizyphus spina christi*) Grown in Sultanate of Oman and Their Potential Health Effects

Name of Student: Vandita Singh
Supervisor: Dr. Nejib Guizani

Current epidemiological studies have indicated that a high intake of fruits and vegetables is associated with reduced risk for a number of chronic diseases. The recent explosion of interest in the bioactivity of the flavonoids of higher plants is due to potential health benefits of these polyphenolic compounds as important dietary constituents. Thus it is important to have a clear idea of the major phenolic families of which fruit and vegetables are comprised and the levels contained therein.

Dates constitute an important agricultural crop in the sultanate of Oman. It was reported that dates have important antioxidant activity due to the presence phenolic compounds. Nabag commonly called Jujube, Red date, or Chinese date is also available in Oman and was reported to possess multiple medicinal properties such as antifertility, analgesic, and antidiabetes. Studies related with Nutritional and medicinal values of dates and Nabag are scanty. Thus the objectives of the thesis are to identify the total polyphenolics and antioxidant content of Omani date varieties (Fard, Khalas and Khasab) at two stages of ripening i.e. Rutab and Tamer and of Nabag, to characterize the polyphenols present in the fruit extracts using GC-MS, to study their antimicrobial activities and compare the influence of Omani date varieties (Fard, Khalas and Khasab) and Nabag on Isoproterenol induced myocardial infarction in experimental rats.

Thesis Abstracts of Students Graduated in 2009

Effect of Low Voltage Electrical Stimulation on Meat Quality Characteristics of Omani Camel

Student Name : Yaqoub Ali Saif Al-Hosni
Supervisor : Dr. Isam Kadim
Department : Animal and Veterinary Sciences

Abstract

Two experiments were conducted to study the effect of low voltage electrical stimulation on histochemical, structural and meat quality characteristics of Omani camel carcasses. The first experiment was carried out to evaluate the effects of stimulation and ageing (2 vs. 7 days) on meat quality of four age groups of camel (1-3, 4-6, 7-9 and 10-12 years old). Warner-Bratzler shear force, pH, sarcomere length, myofibrillar fragmentation index, expressed juice, cooking loss and L*, a*, b* colour were measured in 72 camels. Age of camel and electrical stimulation had a significant effect on meat quality of *Longissimus thoracis* muscle. The histochemical staining properties of the myosin ATPase and succinate dehydrogenase stains were also evaluated. Electrical stimulation resulted in a significantly ($P<0.05$) more rapid muscle pH fall of muscle during the first 12 hr after slaughter. Muscles from electrically-stimulated carcasses had significantly ($P<0.05$) lower pH values, longer sarcomeres, lower shear force value and higher expressed juice than those from non-stimulated ones. Electrically-stimulated meat was significantly ($P<0.05$) lighter in colour than non-stimulated based on L* value. Muscles of 1-3 year camels had a significantly ($P<0.05$) lower shear force value, and pH, but longer sarcomere, and higher myofibrillar fragmentation index, expressed juice, and lightness color (L*) than those of the 10-12 years camels. The proportions of Type I, Type IIA and Type IIB in camel muscle were 25.0, 41.1 and 33.6%, respectively. Muscle samples from 1-3 year camels had significantly ($P<0.05$) higher Type I and lower Type IIB fibres compared to those from 10-12 year camel samples. These results indicated that age and electrical stimulation had a significant effect on camel meat quality.

The second experiment aimed to evaluate the effect of splitting carcasses and stimulation on histochemical, structure and meat quality characteristics of two age groups camels (1-2 vs. 8-10 year old). Thirty camels were randomly assigned to one of four treatments: non-stimulated and electrically-stimulated; unsplit carcasses and split carcasses. The split carcasses were longitudinally split along the vertebral column. A low voltage electrical stimulation was applied 20-30 min post-mortem. The Longissimus thoracis muscle pH, sarcomere length, myofibrillar fragmentation index, shear force, expressed juice, cooking loss and CIE L*, a*, b* colour values were measured. The histochemical staining properties of the myosin ATPase and succinate dehydrogenase stains were evaluated. Electrical stimulation

resulted in a significantly ($P<0.05$) more rapid pH fall in muscle during the first 12 hrs post-mortem. Muscles from stimulated samples had significantly ($P<0.05$) lower pH, longer sarcomere, lower shear values than those from non-stimulated ones. Myofibrillar fragmentation index and expressed juice were significantly ($P<0.05$) higher for stimulated than for non-stimulated samples. Meat from stimulated samples was significantly ($P<0.05$) lighter (L*) in colour than non-stimulated samples. There were no differences in muscle quality between split and unsplit carcasses. Muscles of 8-10 year old camels had significantly lower expressed juice, cooking loss, darker (L*) more red (a*), more yellow (b*) and higher pH and myofibrillar fragmentation index than those from 1-2 year old animals. This experiment indicated that electrical stimulation improves quality characteristics of meat from unsplit and split carcasses.

Effects of Fish Silage on Broiler Chicken Performance and Meat Quality Characteristics

Student Name : Mariam Ali Mubarek Al Farsi
Supervisor : Dr. Waleed Al Marzooqi
Department : Animal and Veterinary Sciences

Abstract

The feed industry, in the Sultanate of Oman is stable only through importation of up to 100% of feed ingredients, which increases the cost of formulated diets. This results in the cost of production of livestock in general and poultry in particular becoming relatively higher. Therefore, looking for local and cheap protein and energy feed resources is of high priority especially that the feed cost is increasing globally. In the Sultanate of Oman, fish by-products, such as sardines which are available at reasonable prices and have the potential to be used as a high protein supplements for broiler chicken feeding.

A simple method was used for fish silage making which can be feasibly adopted by local fishermen or small scale farmers. Fish silage was prepared from ground Indian oil sardines (*Sardinella longiceps)* using inorganic acid (3% hydrochloric acid). Fish silage was dried on crushed corn. A mixture of 85% fish silage: 15% crushed corn ratio was prepared and gave the same crude protein content as in soyabean meal on dry matter basis.

Two experiments were conducted to evaluate the use of fish silage as a partial replacements of soyabean meal as a source of protein for growing broiler chicken. The main objective of Experiment 1, ileal digestibility assay was to assess the nutritional value of fish silage compared with soyabean meal for feeding broiler chicken. The two test ingredients, soyabean meal and dried fish silage, were incorporated individually into semi-synthetic diets, as the only source of protein. The digestibility coefficients of amino acids of fish silage were considerably higher than those of soyabean meal ($P<0.001$). The lower digestibilities of amino acids for soyabean meal is probably related to the presence of antinutritional factors such as trypsin inhibitors. Soyabean meal had lower level of sulphur-containing amino acids than fish silage. For the most important essential amino acids for poultry performance; fish silage contained 66% more methionine; 24% more threonine and 34% more lysine than soyabean meal.

The objective of Experiment 2, growth study, was to evaluate the effect of feeding fish silage on broiler chicken performance and meat quality characteristics under closed and open-sided housing systems. Four diets containing (0, 10, 20 and 30% fish silage) were evaluated. Daily feed intake, body weight gain and feed conversion ratio were measured. At the end of

experiment 2, 96 birds were randomly selected and slaughtered to evaluate meat chemical composition and meat quality characteristics. Housing type had significant effects on broiler performance with birds in closed house performing better than those in open-sided house. Birds in both houses fed diet 10 and 20 % fish silage gained more than other birds fed diet 30% fish silage. However, birds fed the 30 % fish silage diet had lower panel taste score flavor. In general, the current study produced evidence that fish silage can replace up to 20% of soybean meal in broiler diets without affecting performance and sensory quality of broiler meat.

Effects of Feeding Various Levels of Fish Silage on Performance, Carcass and Meat Quality Characteristics of Omani Sheep

Student Name : Abdullah Salman Saleh Al Abri
Supervisor : Prof. Osman Mahgoob Gaafar
Department : Animal and Veterinary Sciences

Abstract

This study was conducted to use local fish resources to produce fish silage that have a potential to be used as a low cost rich protein supplements for livestock feeding in Oman. A simplified modified method was used for silage making to be feasibly adopted by local fishermen or livestock producers. Fish silage was prepared from ground Indian oil sardines (*Sardinella longiceps*) using inorganic acid (hydrochloric acid) without addition of antioxidant and no neutralization for pH before use. Fish silage was sun-dried on wheat bran (75:25) before being mixed with other feed ingredients in sheep diets. Chemical characteristics of the fish silage and fish containing diets were evaluated. Forty Omani sheep were used in a feeding trial to one of five diets, formulated from fish silage, soybean meal, barley, wheat bran, ground date palm leaves, limestone, vitamin and mineral mix, salt and vegetable oil. The proportions of fish silage in the diet were 0, 5, 10, 15 and 20% whereas the parallel soybean meal ranged from 17 to 0%. The experimental diets were isonitrogenous (17% crude protein) and isoenergetic (15 kJ/gm gross energy). Animals were housed in individual pens and daily feed intake and weekly body weights were recorded. The experiment spanned 18 weeks with the first 2 weeks of adaptation. Animals were fed 500 g/d of the concentrates and allowed *ad libitum* access to hay, water and trace elements. A three week (one week adaptation and 10 days collection) digestibility experiment was carried out on twelve sheep fed 0, 10 and 20% fish silage (four sheep per diet). The fresh fish silage dry matter was 39.3% and it contained 51% crude protein, 22% ether extract, 15.3 ash, 3.4 calcium and 3.1 phosphorus. The 75:25 silage: wheat bran contained 88.3 DM, 39 crude protein, 13.9 ether extract, 12 ash, 1.7 Ca and 1.7 Phosphorus. No ill health signs were observed on experimental animals. Haematological and biochemistry investigations showed no treatment effects on blood parameters. There were no differences ($P>0.05$) in digestibility coefficients of crude protein, acid detergent fibre, and neutral detergent fibre between 0, 10 and 20% fish silage diets. However, the 20% silage diet had lower ($P<0.001$) DM, ash, Ca, P and energy digestibilities. There were no treatment effects on hay, concentrate or total feed intake; total body weight gain or gain per kg/body weight of experimental animals. Sheep fed the 0, 5, 10, 15 and 20% fish silage diets had average daily body weight gains of 105, 115, 107, 101 and 96 g/d, respectively. There were no diets effects on body composition, carcass characteristics, meat quality or sensory evaluation. This study indicated that fish silage can be prepared easily using a simple technique that can be adopted by any small scale farmers under Omani conditions. Fish silage may be incorporated in sheep diets at levels up to 20% without negatively affecting their performance. Fish silage offers a cheap high protein supplement for feeding livestock in Oman and would reduce feed cost and increase farmer's profit.

Effects of Feeding Salt Tolerant Sorghum Forage on Growth Performance, Carcass and Meat Quality of Omani Sheep

Student Name : Said Shannan Ali Al Khalasi
Supervisor : Prof. Osman Mahgoob Gaafar
Department : Animal and Veterinary Sciences

Abstract

This study was conducted to evaluate the use of the salt tolerant sorghum (*Sorghum vulgare*, *S. bicolor* (L.) as a potential tolerant to saline water and efficient water user that may provide a good source of roughage for livestock feeding in Oman. Sorghum variety (Super Dan) planted and irrigated with the three levels of saline water: 3 (S1), 6 (S2) and 9 dS m^{-1} (S3). It was manually harvested, dried, chopped and fed to experimental animals. Twenty eight, 3-month-old Omani male lambs with average body weight of 22.2 (± 1.2) kg were distributed according to body weight (BW) into four groups of seven lambs each. The first group was fed a control diet of Rhodes grass hay (RGH) plus 300 grams of commercial concentrate each. The other groups were given sorghum hay irrigated with three different level of water salinity (3, 6 or 9 dS m^{-1}) each plus 300 grams commercial concentrate. Daily feed intakes and weekly body weights were recorded and the experiment lasted for 9 weeks. A digestibility trial was carried out on 12 animals (three sheep per diet) consisting of 10 days of adaptation and a subsequent 10 days collection period. Blood samples were collected three times at day one, day 33 and day 66 at the end of the experiment and analyzed for haematological and serum biochemistry levels to assess animal health. At the end of the trial the animals were slaughtered and their carcass and meat quality assessed. Chemical analyses indicated that RGH had higher mineral content than sorghum forage grown under various levels of salinity. Animals fed sorghum based diets did not show signs of ill health. The hematological and serum biochemistry were not affected by dietary treatments. There were no differences ($P>0.05$) between RGH and other treatments in digestibility coefficients of acid detergent fibre (ADF), neutral detergent fibre (NDF), and ether extract (EE) between RGH, S1, S2 and S3 diets. However, the S1 diet had lower dry matter (DM), crude protein (CP), Ca, P and gross energy digestibilities but higher ash digestibility. There were no treatment effects on hay, concentrate or total feed intake; total body weight gain or gain per kg/body weight (BW) of experimental animals. The RGH-fed animals had higher S and Zn contents in faeces and a higher S content in meat. Sheep fed the RGH, S1, S2 and S3 diets had average daily body weight gains of 96, 84, 82 and 68 g/d, respectively. There was no diets effect on rumen condition except that RGH fed animals had lower N-ammonia and butyric acid concentration. There were no significant differences on body composition, carcass characteristics, meat quality or minerals contents. Transmission electron microscopy investigating on sheep kidneys and livers showed no morphological or pathological changes for animals of different treatments. This study indicated that sorghum forage grown under high salinity levels may be used for feeding Omani sheep without adverse effects on health, performance or carcass and meat quality characteristics. It offers a good use of saline water and soils in many parts of the country affected by salinity.

Resistance of Whitefly (*Bemisia tabaci*) to Selected Organophosphorus Insecticides in Oman

Student Name : Laila Ali Salim Al-Subhi
Supervisor : Dr. Farid Talukder
Department : Crop Sciences

Abstract

An insecticide resistance detection bioassay on sweet potato whitefly, *Bemisia tabaci* (Hompotera: Aleyrodidae), a major Omani vegetable insect-pests was carried out under laboratory conditions for acetyl cholinesterase inhibition. The whitefly samples were collected form eighteen vegetable production farms from the Northern Oman (Al-Batinah region). Technical grade malathion, diazinon, dimethoate and chloropyrifos with different concentrations (0, 5, 10, 25, 50 and 100 ppm) were tested for their insect enzyme inhibition activity through Microplate reader system. *In-vitro* enzyme assay data showed different levels of insecticide resistance in whitefly populations collected from different fields. For instance, the lowest inhibition rate (IR) for diazinon was recorded 35.08 % and the highest value was 70.00 % by 30 minutes and at concentration of 100 ppm. For malathion IR value range from (72.00 to 87.00 %) by 30 minutes and at concentration of 100 ppm. Dimethoate IR value ranged from 66.67 to 85.05% by 30 minutes and at concentration of 100 ppm. For, chlorpyrifos the maximum IR values of 59.50% and the lowest value of 46.00% by 30 minutes and at chlorpyrifos concentration of 100 ppm. Despite their different fields' locations, insect samples, showed variable inhibition rates toward the four insecticides, as 87.00 % to malathion, 85.05% to dimethoate followed by diazinon (70.00 %) and the lowest to chlorpyrifos (59.50%) by 30 minutes and at concentration of 100 ppm. When same whitefly samples (collected from same field) were compared for their resistant level to two different insecticides (diazinon and malathion), variations in insecticides resistance were observed, When IR (median inhibition rate) were compared between diazinon and malathion, results showed that malathion was more toxic (IR_{50}= 16.94 ppm) than diazinon (IR_{50}= 144.03 ppm). Whitefly population showed high level of resistance, i.e. 93.42-12.10 fold to diazinon, 6.88-11.85 folds to Malathion, 13.97-17.10 folds to dimethoate and 592.33-22.67 fold to Chlorpyrifos. Current results indicate that the whitefly *(B .tabaci)* populations in different vegetables farms in Al-Batinah region had different degree of resistance against organophosphorus insecticides, especially Malathion, Diazinon, Dimethoate and Chlorpyrifos.

Fruit Flies of Oman: Their Identity, Distribution, Host Plants, Parasitoids and Physical Control Using Bagging of Mangoes

Student Name : Mahmoud Saleh Al Ansari
Supervisor : Dr. Michael Deadman
Department : Crop Sciences

Abstract

Fruit flies are the most destructive insect pests attacking many types of fruits in Oman causing serious damage. A survey was carried out to determine which species are present, their abundance, and their host range. In addition, bagging of fruits and the presence of biological controls, as more effective and environmentally safer alternative control methods to the currently- practiced insecticide-based control methods, was investigated.

In this study, Tephritid fruit flies were surveyed using male lure (methyl eugenol) traps and by collection of host fruits over 3 years (May 2003–September 2006) in 100 sites from different regions of Oman. Six fruit fly species, *Bactrocera zonata, B. Oleae*, *Dacus ciliatus, D. longistylus*, *Carpomya incompleta* and *C. vesuviana*, were collected and identified from 54 host plants. Five species, *B. zonata, B. oleae*, *D. ciliatus, C. vesuviana,* and *C. incompleta*, were of economic importance. The species most common in traps was *B. zonata* and was the only generalist species. Fruit flies were reared from 20 out of 35 sampled commercial plant species. The two export crops (lime and dates) were not hosts for any of these fruit fly species.

Data from bagging experiment to protect 5 different mango cultivars, Zafaran, Rasfory, Totapuri, Omani and Hindi-Abosenara, from fruit fly showed that there was significant difference between bagged and un-bagged fruits. The three bagging treatments significantly protected the fruits from fruit fly attacks compared to control un-bagged fruits (F= 76.09, P= 4.45E-08). The comparison among the three treatments showed that newspaper and agril were more efficient than green mesh bags.

Two parasitoids, *Opius* sp. and *Eucoiline*, were reared and identified in the study. However, their effectiveness as biological control agents against remains to be investigated.

Data from this study emphasize the need for use of effective control methods and implementation of strict quarantine measures against fruit fly pests that can complicate the development of fruits and vegetables production and export industry.

Biological Control of Dubas Bug (*Ommatissus lybicus* Bergevin) Using Local Microbiological Agents

Student Name : Najma Mahmood Al-Zidjali
Supervisor : Dr. Michael Deadman
Department : Crop Sciences

Abstract

Dubas bug biocontrol using different locally isolated microbial agents was examined by testing their efficacy against the different stages of Dubas bug, first *in vitro* at the laboratory level, then *in vivo* under controlled conditions within small cages and finally under insect proof shade in field conditions.

The general objective of this research was to develop a safe biocontrol method in order to preserve the bio-ecological balance, and to reduce the economical damage induced by the Dubas bug on date palm trees and to reduce chemical pesticide use.

Different microbial treatments were tested by ground spray comparative to an untreated control, at different generation period targeting eggs, nymphs or adults. Egg hatching, nymph development, adult number and sex-ratio, as well as induced damage were weekly recorded to evaluate the efficiency and the sustainability of the tested microbial treatments.

PCR and SEM investigations showed that Dubas bug is associated with symbiotic/mutualistic bacteria *Arsenophonus* sp. (DBY06). Screening Dubas bug for specific symbionts confirmed the occurrence of *Arsenophonus* within all populations and different stages using PCR sequence of specific *Arsenophonus* probes. This newly assumed symbiotic DBY06 bacterium, naturally associated with Dubas bug, is reported for the first time in Oman.
The effect of *Enterobacter cloacae* (DBY05) on eggs and *Arthrobacter aurescens* (DBW05) on adults was confirmed. However, the beneficial effect was not sustainable, because reducing Dubas bug adult number, resulted in the Dubas bug population building-up at the next generation.

Effect of DBY06*, an antagonistic bacteria toward *Arsenophonus* (DBY06) showed the greatest effect on Dubas bug egg hatching rates, nymphs and adults densities, as well as on the Dubas bug damage observed on infested date palm seedlings.

Research investigation on Dubas bug biological control in Oman fits with the Symbiont-Based Protection (SyBaP) or "symbiotic control", a new approach with the aim of using insect symbionts for the control of major agricultural pests.

Development of Insect Resistant Potato Cultivars via *Agrobacterium* Mediated Transformation with *Cry*1Ac Gene Expressing δ-Endotoxin

Student Name : Ali Saleh Abdullah Al- Forqani
Supervisor : Dr. Akhtar Jamal Khan
Department : Crop Sciences

Abstract

Potato cultivation has increased in Oman since 1989 as consumer demand for potato products has risen. Tuber moth *(Phthorimaea operculella*) insect is a serious constraint to the potato production in Oman. The emergence of *Bacillus thuringiensis* resistance in many economically important crops has gained the attention of many researchers. Transgenic plants expressing *B.t* genes in tissues have increased in popularity as the chosen form of pest control. *B.t's* derived gene expressing the endotoxin *Cry*1Ac was inserted into potato plant by (*Agrobactirum. tumefaciens)* in order to develop resistance against potato tuber moth *(Phthorimaea operculella*). The transgene (*Cry1* Ac) is expressed in all parts of the plant throughout the season whereas traditional insecticides lose their toxicity with time. The insecticidal proteins, δ-endotoxins expressed by *Cry*1Ac are specifically lethal to Lepidopteran insects. *Cry*1Ac coding sequences from *B. thuringiensis* has been constructed into *Agrobacterium* vectors plasmids (pRD400) and driven by double 35S CaMV promoter suitable for dicot transformation using kanamycin resistance gene as marker. Transgenic callus of potato has been grown on modified MS medium containing 500 mg/L carbenicilin and 300 mg/L kanamycin. DNA extraction, PCR amplification and ELISA, have verified the integration of *Cry*1Ac gene into potato genome. Bioassay of Potato tuber moth was tested in transgenic potato and mortality was found more than 80%.

Effect of Mineral Fertilizers and Desuckering on Growth and Yield of Banana in Al-Batinah, Oman

Student Name : Khalid Mubarak Saleh Al Harthi
Supervisor : Dr. Rashid Al-Yahyai
Department : Crop Sciences

Abstract

A field experiment was carried out at Al-Batinah International Company (BIC), Al- Suwaiq, Al-Batinah Region, Sultanate of Oman during 2005-2006. The objective of the study was to study the effect of different rates of a combination of N, P and K fertilizer, desuckering to one or two suckers per mat and their interaction on growth and yield of 'Williams' banana (*Musa accuminata* Colla). A split plot design was used with one or two suckers per mat as main plot and a combination of three levels of chemical fertilizers, i.e. N (300, 600 and 900 g/ mat/yr.), P (50, 100 and150 g/mat/yr.) and K (250, 500 and 750 g/mat/yr.) in addition to non-fertilized control (no NPK applied) treatment as sub-plots treatments. The fertilizer treatments were arranged in a Completely Randomized Block Design with three replication mats. Different combinations of chemical fertilizer resulted in significant difference in both vegetative growth and yield of banana. The vegetative growth of non-fertilized plants was significantly higher in all measured parameters compared to fertilized banana plants. Fertilizing with NPK at the levels of 600, 100 and 500 gm/ mat / yr., respectively, had significantly better yield and post-harvest characteristics under either one or two suckers per mat than all other treatments. For this fertilizer treatment, the total bunch weight, middle hands weight and number of fingers per middle hands were 14.98 kg, 13.47 kg, 1.365 g and 16.05 respectively. Despite the numerically higher fruit production with two suckers per mat compared to one sucker, there were no significant differences in growth, yield or fruit quality. There were little differences among other fertilizer treatments on the vegetative and reproductive growth, yield and fruit quality of 'Wiliams' Banana. From the results of the present study, the recommended rate of NPK fertilizer for 'Wiliams' banana in Al-Batinah region of Oman is 600, 100 and 500 g/mat/yr.

Incidence and Growth Characteristics of *Enterobacter sakazakii* Isolated from Powdered Infant Formula (PIF) Milk on Sale in Dubai

Student Name : Yousef Saeed Al-Saadi
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Department : Food Science and Nutrition

Abstract

Enterobacter sakazakii is an emerging pathogen associated with life-threatening neonatal infections resulting from the consumption of contaminated powdered infant formula (PIF) milk. Recent taxonomic analyses have determined that *E. sakazakii* comprises a number of genomospecies, and it has been proposed that *E. sakazakii* be reclassified as a novel genus, "*Cronobacter*". *E. sakazakii* is an opportunistic pathogen and is rarely reported, little is known about the ecology of *E. sakazakii*. However, *E. sakazakii* has been found in manufacturing equipment which is a potential source of contamination for powdered infant formula (PIF) after pasteurization. This study was conducted to determine the risk of using infant formula for *E. sakazakii* infection and to identify any potential risks if the product is mishandled. Stores in Dubai were surveyed to determine the market availability of PIF and packaging details were recorded. Random samples were analyzed for *E. sakazakii* and aerobic colony count (ACC). There were 18 different companies exporting their products for sale in Dubai. The most common method of labelling was direct printing onto the can without any paper. This was observed on 91% of the samples studied. All of the products used bilingual labelling and most of them (91%) were using Arabic and English. Nine samples (6%) were found to be contaminated with *E. sakazakii*. *E. sakazakii* contamination did not correlate with ACC results which ranged between <10 CFU/g and 5.6 X 10^3 CFU/g.

The disc diffusion method in addition to the Becton Dickinson Phoenix system was used to determine the antimicrobial susceptibility of *E. sakazakii* isolates. The *E. sakazakii* isolates were resistant to the following antibiotics: cephalothin, cefoxitin, ampicillin and amoxicillin/ clavulanate. This could have an influence on treatment.

Growth rates were determined using PIF reconstituted at 23°C and 37°C, the average generation times were 73 min and 25 min respectively. *E. sakazakii* takes a short time to double at 37°C, a common ambient kitchen temperature in the Gulf.

D-values were determined using the survival curve method at temperatures of 50°C, 60°C, 70°C and 80°C. They were 909; 0.87; 0.32 and 0.15 min respectively. *E. sakazakii* was significantly tolerant when exposed to 50°C, the recommended reconstitution temperature.

This study concluded that there is a risk, especially if PIF milk is mishandled and therefore *E. sakazakii* should be included in the Gulf Standard for PIF milk and also correct labelling of cans and instructions should be included in the standard.

Effects of Lifestyle on Prevalence of Prediabetes in a Selected Population in Oman

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Abstract

Diabetes mellitus (DM) is a growing worldwide health problem. It is recognized as a group of heterogeneous disorders with the common elements of hyperglycaemia and glucose intolerance. Prevention of diabetes is based on a better understanding of pathophysiology of the disease and early identification of the associated risk factors in apparently healthy individuals. The present study aimed to investigate the prevalence of prediabetes in a selected population of wilayatt Bidbid and to examine association of lifestyle factors such as sociodemographic, diet, obesity, and physical activity with the risk of prediabetes. Community based cross-sectional study was conducted to identify individuals with prediabetes as per WHO 1999 diagnostic criteria. Anthropometric measurements, biochemical data including plasma lipid profile, fasting and oral glucose tolerance tests were performed. A validated comprehensive questionnaire on socio-demograhic status, dietary intake, and physical activity assessment was conducted as well. Descriptive analysis was used to determine prediabetes prevalence. Logistic regression was applied to predict risk factors of prediabetes by obtaining odds ratio (OR) and their 95% confidence interval (CI). Out of 1219 participants, 19.5% were found to be prediabetics and 6.2% were newly diagnosed diabetics. 10.7% of prediabetic subjects were diagnosed as impaired glucose tolerant (IGT), 5.7% as impaired fasting glucose (IFG), and 3.2% were with both IFG and IGT. Sociodemographic determinants such as age (OR= 6.8, 95% CI = 3.1-15.0) and educational status were significantly associated with elevated risk of prediabetes. Individuals of 60 years old or more were 6.8 times at higher risk of developing prediabetes than those of 18 to 19 years (OR= 6.8, 95% CI = 3.1-15.0). The risk of being prediabetic was 3.4 times higher among illiterates compared to university graduates (OR = 3.4, 95% CI = 1.5 –7.6). Age and gender adjusted logistic regression revealed that obesity (BMI ≥ 30 kg/m^2) was associated with increased risk of prediabetes (OR= 2.6, 95% CI = 1.8-3.8). The risk of being prediabetic elevated among subjects with large waist circumference (WC) by 2.3 times than those with normal WC (OR = 2.3, 95% CI = 1.6-3.3). Subjects who were with high waist to hip ratio (WHR) increased their risk of prediabetes by 2.1 times compared to those with normal WHR (OR = 2.1, 95% CI= 1.5-2.9). However, no statistically significant association was obtained between dietary intake of various food groups and risk of prediabetes.Total leisure time exercise metabolic equivalence task per week (MET/week) contributed to the lower risk of prediabetes only among the individuals in the highest

quartile group (OR = 0.5, 95% CI = 0.3-0.9), whereas walking pace and Total MET/week spent on walking were insignificantly associated with the risk. Individuals of 40 years old or more, lower educational status, overweight or obese especially of large waist circumference and waist hip ratio, and characterized with abnormal lipid profile, irrespective of their dietary intake, were at higher risk of developing prediabetes. In conclusion, illiteracy, obesity, abdominal obesity, sedentary lifestyle appears to be markedly associated with the risk of prediabetes. Thus, a community-based multiple strategies are required to combat the increasing rate of prediabetes and its subsequent end stage of DM.

Dietary and Lifestyle Factors and Risk of Non-Hodgkin's Lymphoma in Oman

Student Name : Buthaina Saleh Al-Belushi
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Department : Food Science and Nutrition

Abstract

The study examined the associations between dietary and lifestyle factors and risk of non-Hodgkin's lymphoma (NHL) in Oman. Forty three histologically confirmed NHL cases diagnosed at Sultan Qaboos University Hospital (SQUH) and Royal Hospital, Muscat, Oman and their forty three age matched controls were used in this case-control study. A frequency matching was used in selecting the population based controls to achieve similar age and sex distribution to that of all cancer cases. Dietary intake information was collected in personal interviews with cases and control subjects, using a 117-item semi-quantitative food frequency questionnaire. The statistical analysis of the data was conducted using the odds ratios (OR) and 95% confidence intervals (95% CI), calculated from the maximum likelihood estimates using the binary logistic regression. A non-significant increased risk of NHL was observed with higher body mass index (BMI) (OR= 1.20, 95% CI: 0.45, 2.93), whereas a significantly decreased NHL risk was observed to be associated with higher educational level of respondents (OR= 0.12, 95% CI: 0.03, 0.53). When the highest quartile of intake was compared with the lowest, a significantly increased risk was observed for higher intake of energy (OR= 2.67, 95% CI: 0.94, 7.57), protein (OR= 1.49, 95% CI: 0.54, 4.10) and carbohydrate (OR= 5.32, 95% CI: 1.78, 15.86). Higher consumption of daily servings from cereals (OR= 3.25, 95% CI: 0.87, 12.09) and meat groups (OR= 1.55, 95% CI: 0.58, 4.15) were found to be associated with NHL risk, whereas a significantly reduced risk was associated with higher consumption of vegetables (OR= 0.24, 95% CI: 0.07, 0.82). The consumption of fruits and milk however did not show any significant association with NHL risk. No apparent association was observed between the fat intake and percentage contribution of energy from various macronutrients with NHL risk. Overall, the results of the present study suggested that diet has an association with NHL risk.

Total Lipid and Fatty Acid Content of Farmed Tilapia

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Abstract

Freshwater carp and tilapia are the dominant groups of fish produced by aquaculture. Compared with marine fish, the body lipids of freshwater fish generally contain lower levels of nutritionally beneficial long chain n-3 polyunsaturated fatty acids (PUFA), including eicosapentaenoic acid (EPA) and docosahexanoeic acid (DHA). With current interest in the quality and health benefits of fish to consumers, recent attention has focused on the origins and amounts of long chain fatty acids in various farmed freshwater species and on the effects of diet and farming methods on fatty acids content.

In the present study, the total lipid and fatty acids content of semi-intensively farmed, Genetically Improved Farmed Tilapia (GIFT) strain (*Oreochromis niloticus*) was examined and the fatty acids content of both natural and supplemented feeds was determined. Analytical results from commercial feed revealed n-3 PUFA levels of 1.9% of total fatty acids. Plankton samples contained similar total amounts of n-3 PUFA (2.0% of total fatty acids) whilst dorsal muscle (fillet) samples contained 4.8% of total n-3 fatty acids. These results indicate that n-3 PUFA accumulate in muscle lipids. The amounts of EPA and DHA in the dorsal muscle samples were 0.9 and 2.9% of total fatty acids respectively. These values exceed those reported elsewhere for Nile tilapia grown in intensive culture systems with no access to natural food and provide further evidence of the key role of plankton as a dietary source of n-3 PUFA.

In a second experiment red hybrid tilapia (*Oreochromis sp.*) were fed isonitrogenous and isoenergetic diets containing 0, 4, 8, and 12% cod liver oil, substituted against corn oil, with n-3/n-6 ratios of 0.1, 0.2, 0.6 and 1.0 respectively. After feeding triplicate groups, each of 20 fish, for 10 weeks no significant differences were seen in weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio, condition indices, whole body or fillet proximate composition. Significant ($P < 0.05$) differences were however seen in the fatty acids content of dorsal muscle. There was evidence of selective retention of DHA in the dorsal muscle, where levels significantly exceeded dietary levels. The retention of EPA was low in all dietary groups but was significantly higher in the diet containing 12% cod liver oil. There was no evidence from this study of accumulation of arachidonic acid in the dorsal muscle of treated fish. This has recently been linked to potential production of undesired eicosanoids in some farmed tilapia. The significant

decreases in linoleic acid in dorsal muscle samples, as dietary corn oil was reduced, and increase in total n-3 PUFA and DHA contents as dietary cod liver oil was increased, indicate the potential to modify favorably n-3/n-6 ratios of fatty acids in tilapia fillets by dietary manipulation. These ratios increased from 0.1 (fish fed 0% cod liver oil) to 1.44 (fish fed 12% cod liver oil).

These results illustrate the contribution of plankton, in the diets of fish farmed in 'green water' systems, to the n-3 PUFA content of tilapia filets. The feeding and growth experiments conducted with red hybrid tilapia provide further evidence of the potential to increase the n-3 PUFA content of tilapia fillets by increasing dietary n-3 PUFA sources.

Antimicrobial and Antifouling Activities of Soft Coral Extracts from Bandar Al-Khayran in Sultanate of Oman

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Department : Marine Science and Fisheries

Abstract

Soft corals are sedentary animals that lack mechanical defense but evolved sophisticated chemical defense. In our study we collected six dominant soft coral species from Bandar Al-Khayran region (Sultanate of Oman) and tested bioactivity of their methanol: chloroform (1:1) extracts against biofouling and pathogenic bacteria using the disc diffusion method. The soft coral species were identified as *Sarcophyton* sp., *Sinularia* sp.1 and sp.2, *Cladiella* sp., *Scleronephthya* sp. and *Dendronephthya* sp. All tested extracts had some activity against human pathogens, while the highest antimicrobial activity was observed for the extracts of *Sinularia* sp.1 and *Cladiella* sp. The crude extract of *Scleronephthya* sp. has shown activity against *Escherichia coli* resistant to streptomycin. Only the ethyl acetate extract of *Cladiella* sp. showed considerable activity against the marine biofouling bacterium *Bacillus* sp. The antifouling compound from this extract was purified and identified as hydroxytritriacontanoic acid. Comparison of the soft coral extracts revealed that composition of the extracts was highly different in different species and there was no correlation between bioactivity of the coral extracts (number of species inhibited) and the chemical complexity of the extracts (number of non-polar compounds present). This investigation is the first study of the marine natural products in Sultanate of Oman and it showed high potential of soft corals from Oman as a source of biologically active natural products that can be used in industry and pharmacology.

A Comparative Study of Dates Export Supply Chain Performance: The Case of Oman and Tunisia

Student Name : Mohammed Sulaiman Rashid Al-Shabibi
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Department : Natural Resource Economics

Abstract

According to the 2004/2005 agricultural census, there are an estimated 7.8 million date palm trees grown throughout the Sultanate, occupying about 50 percent of the planted area, employing a significant number of Omani people directly and indirectly. Despite this importance of dates, statistics shows that in 2006 the Sultanate ranked 9th in the world in dates production far behind its neighbors such as Egypt, Iran, Saudi Arabia, United Arab Emirates and Pakistan.

In fact, dates production has been declining since 2001, the year that date production reached its highest level in the Sultanate in recent years. Export disincentives which include poor quality output, absence of a well coordinated supply chain and lack of aggressive export promotion, in addition to the 2002 to 2004 drought, have been widely recognized as leading reasons behind the decline in dates production. Among dates exporters in the world, Tunisia is leading in terms of export unit value and total export value, as a result, Tunisia is taken as a benchmark in this study.

The purpose of this study is therefore two fold. First, is to apply the benchmarking approach employed by Garcia et al (2004) to the dates export supply chain in Oman and Tunisia in order to identify gaps in the organizational and operational structures of the export supply chain in the two countries. Second, is to utilize the information generated (regarding the gaps) to put forward recommendations to improve Omani dates export supply chain. For the purpose of this study, the benchmarking measures were put into two groups, namely qualitative and quantitative. The qualitative group has three dimensions whereas the quantitative group has one dimension only. Each of the four dimensions is comprised of a number of Key Performance Indicators (KPI). It is these KPIs that are used to identify the gaps between Tunisia and Oman.

The Tunisian dates supply chain was used as the "Best Practice" or "Benchmark" since in many ways it is more advanced and efficient than the supply chain of other dates producing countries. The analysis required an audit of the export supply chains of both countries. The audit was executed by visiting the exporters in both countries to collect the required data through questionnaires. In total ten date exporters were interviewed, three of

which were Omani and the remaining seven firms were Tunisian. Results from the benchmarking exercise were summarized in a spider-web diagrams to show at a glance multiple targets and gaps.

The results show that Tunisia is performing better than Oman in all the four dimensions. Evaluation of the differences (Gaps) in practices identified in this study will help Omani firms in reviving and improving the Oman date supply chain to levels that will hopefully exceed current leading players such as Tunisia. However, we must be aware that some of the practices that are feasible in Tunisia may not be feasible in Oman as there could be large variations in resource availability, degree of modernisation and market-orientation of Agri-food systems. A careful analysis of the findings should enable Oman policy makers and stakeholders to produce an Industry Action Plan to correct the gaps and take the lead.

Effect of Mulching, Irrigation Rates and Water Quality on Soil Salinization

Student Name : Hamed Sulaiman Ali Al-Dhuhli
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Department : Soils, Water and Agricultural Engineering

Abstract

Sultanate is categorized as arid country with low rainfall and high evapo-transpiration (ET). Ground water is the main source of water for both domestic and agriculture use. High water demand has led to over pumping and prolonged lack of rains has reduced the extent of recharge. This situation has progressively deteriorated the quality of both water and soil towards salinity. The affected areas are mostly the farms near the coast, which have abundant but saline water. Hence, the use of saline water cannot be avoided. Therefore, it is needed that such management practices be devised which ensure sustainable use of saline water with minimum loss to crop yields and least threat to soil health.

This experiment was conducted during summer 2007 at Agricultural Research Center, Directorate General of Agricultural & Livestock Research in Rumais to evolve some practicable and economical management practices, which can mitigate the potential deleterious effects of saline waters to plants and soil. A split block design was applied with 3 factors (Irrigation rates, water salinity and mulch) and 3 replicates. Two categories of irrigation water (EC 3 & 6 d S/m), three level of irrigation quantities (100%, 120% & 140% of ETc), two management practices (Plastic sheet and crop residues mulch=date palm leaves) vs. control, and their interaction on soil EC, plant parameters and yield were investigated. Sorghum forage crop was grown. Moisture percentage and soil temperature underneath different mulches were monitored throughout the experiment.

The results revealed that increasing amounts of irrigation water from 100% to 120% and 140% of ETc increased yields by 20 and 25% (from 47 to 57, and 59 ton/ha) respectively. Data of the experiment indicated that 6 dS/m decreased green forage yield (52 t/ha) compared with 3 dS/m (56.5 t/ha) but also increased soil EC significantly. However, the plastic sheet and crop residue mulch proved greatly helpful to control the bad effects of saline water on crop yield and soil EC. The positive effects of both the treatments were found to be significant over control (No management practice). Date palm leaf mulch proved superior in crop yield. The recorded green yields for date palm mulch, plastic mulch and control were: 58.7, 52.7 and 51.9 t/ha respectively that were assessed as significant statistically. Both type of mulches proved successful in controlling increase in soil EC and keeping it as 2.7dS/m as against 3.6 dS/m for control. Another benefit of date palm

mulch was observed in keeping the soil cool when compared with control as well as plastic mulch. The recorded respective mean temperatures were; 33.2, 34.0 and 35.4. Date palm mulch also proved useful in conserving the moisture and means determined values were 16.5, 14.9 and 14.8 % for date palm mulch, plastic mulch and control respectively.

The effect of Gonu cyclone was also studied. No permanent effect on soil moisture and temperature was recorded but soil EC decreased considerably. Plant parameters remained un-affected with cyclone event.

Effect of Sewage Sludge Application on Heavy Metals Movement in Calcareous Soils

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Department : Soils, Water and Agricultural Engineering

Abstract

Usage of sewage sludge for agricultural purposes is a common practice in many countries around the world. It contains different nutrients and organic matter which are essential for plants. Besides it contains different concentrations of heavy metals such as Cd, Cr, Pb, Mn, Pb and Zn. These heavy metals are essential for plants in trace amount and some are toxic even in small concentrations. When these elements present in the soil, it would be difficult to get rid of them. Because they tend to percolate into the soil surface or percolates to deeper soil layers causing another problem which is ground water pollution.

The objectives of this study were to study the distribution of heavy metals (Cd, Mn, Pb, Zn, Fe and Ca and Mg) in sludge treated soil fraction, to detect the dominant element in sludge treated soil fraction, to compare heavy metals in the control and sludge treated soil samples and to assess heavy metals concentration in the top and bottom soil layers. Open ended columns were filled with sandy loam soil to 45 cm high. Then 260 g of sewage sludge were added to three columns and another three columns were left as control. Distilled water was applied to the columns at a rate of 130 ml three days a week. Then After six months, soil samples were collected and analyzed by sequential extraction method.

The results of this study showed that after sludge application, the concentration of Mn, Fe and Zn (in both layers) and Cd and Pb (in the top layer), were found in the residual fraction in dominant form. Cadmium and Pb in the bottom layer were found in carbonate fraction. Other elements such as Ca and Mg did not affect with sludge application they were in carbonate and exchangeable fraction, respectively, for both layers before and after sludge application.

Thus, elements such as Ca and Mg were in available form to plants before and after sludge application while other elements such as Cd, Mn, Zn and Fe were not in available form because they are strongly bounded to the soil components. Lead on the other hand, tended to percolate to deeper layer of the soil because its concentration in the bottom layer was higher than in the top. Thus lead leached out from the soil to deeper layer with water application.

Water Requirements of Cucumber Grown in Conventional and Seawater Greenhouses in Oman

Student Name : Hamed Ali Salem Al-Busaidi
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Department : Soils, Water and Agricultural Engineering

Abstract

Modern agricultural technology such as greenhouses is suggested as one of the most effective solutions to save water. Over 40 hectares of land is cultivated under greenhouse in Oman. The agricultural sector uses more than 93% of the groundwater in Oman. Many farmers use conventional ways of irrigation scheduling inside greenhouses. The main objective of this study is to determine the effective methods to estimate cucumber water requirements inside two types of greenhouses. Microclimatological data inside both greenhouses were measured using Delta 2e data logger. The ambient weather parameters were also measured using meteorological weather stations installed outside each greenhouse. Class A pan was also installed both inside and outside each greenhouse to estimate the daily evaporation. Four lysimeters, cultivated with single plant each, were installed inside each greenhouse. Drainage from each lysimeter was measured on daily basis to estimate the daily crop water requirement.

Data obtained showed that Seawater greenhouse (SWGH) reduced the ambient temperature by 4.8°C while the conventional greenhouse (CGH) reduced it by 7.4°C. The Relative Humidity (RH) inside both SWGH and CGH were 23% and 20% more than ambient, respectively. CGH RH was always less than 60%, unlike SWGH, which indicated that SWGH is more suitable for cucumber growth since cucumber grow better at 60- 85% RH. Solar Radiation (RS) inside both SWGH and CGH were 4.7 and 4.3 Kw/m2, respectively, which indicated that more shade is required in both greenhouses for a better cucumber growth. Calculation of Evapotranspiration (ET_o) inside both CGH and SWGH using Penman-Monteith (P-M) equation gave daily ET_o of 5.5 and 4.3 mm, respectively. The pan factor (K_{pan}) value inside and outside CGH was adjusted locally based on P-M equation and pan evaporation to obtain K_{pan} value of 0.82 and 0.9 respectively. Adjustment of SWGH outside K_{pan} gave value of 0.78. Based on P-M and K_c values, the ET_c inside CGH was 4.1 mm/day while it was 7.9 mm/day outside the CGH during gravest stage of the crop. On other hand, the ETc values inside and outside SWGH were 1.5 mm/day and 4.1 mm/day, respectively, during flowering stage of the crop.

International Collaborations

International Collaborations

Table12. International collaborations in 2009.

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept / Extent of Benefit
1	University of Kassel, Germany	Collaborative research	Animal & Veterinary Sciences (AVS) / Joint supervision of post-graduate students
2	University of Hohenheim, Germany	Collaborative research (agricultural systems)/ Dr. Andreas P. & Dr. Eva Schecht	AVS / Joint super-vision of postgraduate students
3	Washington State University, USA	Collaborative research (clinical reproduction)/ Dr. Mushtaq Ahmed Memon	AVS
4	University of Porto, Portugal	Collaborative research (molecular genetics) / Dr. Albano Fereira	AVS
5	Massey University, New Zealand	Collaborative research (meat science) / Dr. Roger W. Purchas	AVS
6	University of Queensland, Australia	Collaborative research (gut microbiology) / Rafat Al-Jasim	AVS
7	Centraalbureau voor Schimmelcultures, The Netherlands	Scientific research	Crop Sciences (CROP)
8	Tree Pathology Centre, The University of Queensland, Australia	Scientific research	CROP
9	University of Reading, UK	Collaborative research (pest and disease control)	CROP / Joint supervision of PhD students
10	University of Pretoria, South Africa	Collaborative research (mango disease control)	CROP /Joint supervision of postgraduate students
11	National University of Ireland	Farmer decision making	CROP /Joint supervision of PhD student

Table 12. . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept / Extent of Benefit
12	Stellenbosch University, South Africa	Collaborative research on fruit crops	CROP / Joint supervision of postgraduate students & research work
13	Dept of Plant Pathology University of Georgia, Georgia, USA	SR project on WBDL / Prof. C.J. Chang	CROP Dr. R. Al Yahyai
14	Agricultural University of Faisalabad, Pakistan	SR project on WBDL / Dr. Iqrar Khan	CROP Dr. R. Al Yahyai
15	Tropical Research and Education Center, Univ of Florida, USA	Mango & citrus research projects / Prof. Bruce Shaffer	CROP Dr. R. Al Yahyai
16	Fairchild Tropical Garden, Florida, USA	Mango & citrus research projects / Dr. Richard Campbell	CROP Dr. R. Al Yahyai
17	College of Agricultural & Life Sciences, Univ of Guam, Guam, USA	Mango & citrus research projects / Dr. Thomas E. Marler	CROP Dr. R. Al Yahyai
18	Univ of the Philippines at Los Baños, Laguna, Philippines	Mango and citrus research projects / Dr. Leon O. Namuco Dr. Rachel Sotto	CROP Dr. R. Al Yahyai
19	Miami Subtropical Horticulture Research Station, USDA, Miami, Florida USA	Mango and citrus research projects	CROP Dr. R. Al Yahyai
20	MATFORSK (Norwegian Food Research Institute), Norway	Health related quality of fruits and spices Measurement of allicin in fresh and dried garlic; and functional foods	Food Science and Nutrition (FSN)
21	University of Queensland, Australia	Glass transition of spaghetti	FSN
22	School of Food Technology, University of Tunisia	Use of plant coagulants in cheese manufacture	FSN

Table 12 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept / Extent of Benefit
23	University of Malaya, Kuala Lumpur, Malaysia	Collaborative research work in the area of Neural Network and Fuzzy modeling techniques	FSN/ Prof. S. Rahman
24	International Islamic University, Malaysia	Collaboration in the area of extraction technology and developing health functional foods	FSN/ Prof. S. Rahman
25	Polymer Source Inc., Canada	Collaboration with Dr. Jasim Ahmed for publishing a book entitled "Handbook of Food Process Design", Blackwell Publishing, Oxford, UK	FSN/ Prof. S. Rahman
26	La Rochelle University, France	Collaborative research in the area of characterizing fish skin gelatin and biofuel.	FSN/Joint supervision of Ph. D student/ Prof. S. Rahman
27	University Kebangsaan Malaysia, Malaysia	State diagram of gelatin from porcine, bovine and fish skin; and development of low fat Omani halwa	FSN/Joint supervision of Ph. D student/ Prof. S. Rahman
28	United Arab Emirates University (UAEU)	Characterization of camel milk protein isolates as nutraceutical and functional ingredients	FSN/Dr. A. Al-Alawi, Prof. S. Rahman, Dr. N. Guizani
29	Monash University, Australia	Collaborative research in the area of studying the microbial characteristics of Omani traditional foods	FSN/ Dr. I. Al-Bulushi
30	University of New South Wales, Australia	Collaborative research/ Dr. Gilles J. Guillemin	FSN/ Dr. M. Essa
31	New York State Institute for Basic Research	Collaborative research/ Dr. Abha Chauhan	FSN/Dr. M. Essa
32	Kuwait University, Kuwait	Collaborative research/ Dr. Abdur Rahman	FSN/Dr. M. Essa
33	Institute of Food Industry, University of Tunis II	Collaborative research (milk technology/Dr. Salwa Bornaz	FSN/Dr. N. Guizani

Table 12 . . . .

No.	Organization	Type of Cooperation/ Contact Person	Contact Dept / Extent of Benefit
34	Ajman University, UAE	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
35	H.E.J. Research Institute of Chemistry (HEJRIC), Karachi, Pakistan	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
36	Biotechnology MIRCEN, Iran	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
37	Marine Biotechnology Center, University of North Carolina, USA	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
38	Royal Swedish Academy of Sciences/Marine Station, Sweden	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
39	Institut für Pharmazeutische Biologie und Biotechnologie, Düsseldorf, Germany	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
40	UNESCO Regional Office Doha, Qatar	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
41	UNESCO HQ, Natural Science and Higher Education Paris, France	Collaborative research and capacity building	UNESCO/ Prof. B. Soussi
42	National Centre for Oceanography, UK	Scientific and research cooperation	Marine Science and Fisheries (MSF)
43	Universite de Mons-Hainout	Larvae rearing of sea cucumber	MSF
44	Nova University, Florida, USA	PhD thesis co-supervision	MSF
45	Bigelow Laboratory, USA	PhD thesis co-supervision	MSF
46	University of Maryland, USA	PhD thesis co-supervision	MSF
47	Institut für Pharmazeutische Biologie und Biotechnologie,Germany	Scientific research and cooperation (student exchange)/Prof. P. Proksch	MSF/ Dr. S. Dobretsov

Table 12. . . .

No.	Organization	Type of Cooperation	Contact Dept/Person/ Extent of Benefit
48	Smithsonian Marine Station, Fort Pierche, USA	Scientific research and cooperation/Prof. V. Paul	MSF/ Dr. S. Dobretsov
49	Roxilde University, Denmark	Scientific research and cooperation (student exchange)	MSF/ Dr. S. Dobretsov
50	Institute of Biology of the Southern Seas, Ukraine	Joint data analysis	MSF/ Dr. S. Piontkovski
51	Challenge Program for Water and Food, CGIAR, C/-IWMI, Sri Lanka	Collaborative research and capacity building	Soils, Water and Agricultural Engineering (SWAE)
52	Regional Center for Urban Water Management, Teheran, Iran	Collaborative research and capacity building	SWAE
53	Wageningen Agricultural University, The Netherlands	Collaborative research and capacity building	SWAE
54	International Rice Research Institute, Los Baños, Philippines	Collaborative research and capacity building	SWAE
55	Australian Center for International Agricultural Research, Australia	Collaborative research and capacity building	SWAE
56	International Atomic Energy Authority, Vienna, Austria	Collaborative research and capacity building	SWAE

Publications in 2009

Publications in 2009

Sixty-nine refereed journal publications were recorded for the year 2009. Other publications are shown in Table 13.

Table 13. Summary of total publications in 2009.

Refereed journals	69
Book	1
Book chapters	19
Proceedings/papers/posters/abstracts presented at conferences/symposium/workshops/meetings	60
Abstracts of research presentations (SQU Day 2009) (Oral: 6 Posters: 11)	17
Technical reports	25
Articles in newspapers & other SQU publications	18
PhD dissertations	2
Total	**211**

Refereed Journals

1. **Abdelrahman, H**., B.A. Al Yafie and M.F.A. Goosen. 2009. Evaluation of environmental factors and equipment configuration on efficiency of a solar soil water collector. *International Journal of Environmental Technology and Management* 10 (3/4):260-273.
2. Abed, R.S., **S. Dobretsov** and S. Kumar. 2009. Applications of cyanobacteria in biotechnology. *Journal of Applied Microbiology* 106(1):1-12.
3. Al-Ajmi, A., A.A. Salih, **I.T. Kadim** and Y. Othman. 2009. Barley fodder production under hydroponic system in GCC countries using tertiary treated sewage effluents. II: Chemical constituents and heavy metals contents of barley fodder. *Journal of Phytology* 1:374-380.
4. Al-Ajmi, A., A.A. Salih, **I.T. Kadim** and Y. Othman. 2009. Yield and water use efficiency of barley fodder produced under hydroponic system in GCC countries using tertiary treated sewage effluents. I: Yield and water use efficiency. *Journal of Phytology* 1:342-348.

5. **Al-Ani, M.R., L.U. Opara** and N. Al-Rahbi. 2009. Fruit ripening stage affects lycopene and vitamin C content in tomatoes (*Lycopersicum esculentum*): Nutritional and clinical implications. *Annals of Nutrition and Metabolism* 55(S1):112.
6. Al-Ardhi, F. and **M. Al-Ani.** 2009. Maternal fish consumption and prenatal methylmercury exposure: A review. *Nutrition and Health* 19:289-297.
7. **Al-Attabi, Z.,** B.R. D'Arcy and H.C. Deeth. 2009. Volatile sulphur compounds in UHT milk. Critical Review. *Food Science* 49(1):28-47.
8. **Al-Azri A.R, S.A. Piontkovski, K. Al-Hashmi,** J. Goes and H.R. Gomes. 2009. Chlorophyll *a* as a measure of seasonal coupling between phytoplankton and the monsoon periods in the Gulf of Oman. *Aquatic Ecology*, DOI. 10. 1007/s 10452-009- 9303-02.
9. **Al-Azri A.R., S.A. Piontkovski, K.A. Al-Hashmi**, J.I. Goes and H.R. Gomes. 2009. Seasonal cycle of chlorophyll a and physical-biological coupling in the Gulf of Oman. *Aquatic Ecology*. DOI:10.1007/s10452-009-9303-2.
10. **Al-Bulushi, I**., S. Poole, H. Deeth and G. Dykes. 2009. Biogenic amines in fish: Roles in intoxication, spoilage and nitrosamines formation – A review. *Critical Reviews in Food Science and Nutrition* 49:369-377.
11. **Al-Busaidi, A., S. Al-Rawahy** and **M. Ahmed.** 2009. Response of different tomato cultivars to diluted seawater salinity. *Asian Journal of Crop Science* (2):77-86.
12. Al-Harthi, K. and **R. Al-Yahyai.** 2009. Effect of NPK fertilizer on growth and yield of banana in Northern Oman. *Journal of Horticulture and Forestry* 1(8):160-167.
13. **Ali, A.**, Y.M. Al-Kindi and **F. Al-Said.** Chemical composition and glycemic index of 3 varieties of Omani dates. *International Journal of Food Science and Nutrition* 60 (S4):51-62.
14. **Ali, A., B. Al-Belushi**, I.A. Khan and **F.A. Al-Said.** 2009 Nutritional quality and lycopene content of nine tomato accessions grown in Oman. *Acta Horticulturae* 841:635-639.
15. **Al-Kharusi, L.M.,** M.O. ElMardi, **A. Ali, F.A. Al-Said**, K.M. Abdelbasit and **S. Al-Rawahy.** 2009. Effect of mineral and organic fertilizers on the chemical characteristics and quality of date fruits. *International Journal of Agriculture and Biology* 11(3):290-296.
16. **Al-Masroori, H.S**., H. Al-Oufi and P. McShane. 2009. Causes and mitigations on trap ghost fishing in Oman: Scientific

approach to local fishers' perception. *Journal of Fisheries and Aquatic Science* 4(3):129-135.

17. **Al-Marzooqi, W**. and J. Wiseman. 2009. Effect of extrusion under controlled temperature and moisture conditions on ileal apparent amino acid and starch digestibility in peas determined with young broilers. *Animal Feed Science and Technology* 153:113-130.
18. **Al-Mulla, Y.A**., J.Q. Wu, P. Singh, M. Flury, W.F. Schillinger, D.R. Huggins and C.O. Stöckle. 2009. Soil water and temperature in chemical versus reduced-tillage fallow in a Mediterranean climate. *Journal of Applied Engineering in Agriculture* 25(1):45-54.
19. **Al-Said F.A., L.U. Opara** and **R.A. Al-Yahyai**. 2009. Physico-chemical and textural quality attributes of pomegranate cultivars (*Punica granatum* L.) grown in the Sultanate of Oman. *Journal of Food Engineering* 90(1):129-134.
20. **Al-Wahaibi, A.K.** and J.G. Morse. 2009. Egg morphology and stages of embryonic development of the glassy-winged sharpshooter, Homalodisca vitripennis (Germar) (Hemiptera: Cicacdellidae). *Ann. Entomol. Soc Am.* 102(2):249-260.
21. **Al-Wahaibi, A.K.** and J.G. Moore. 2009. Temporal distribution of egg hatch for two *Homalodisca* Spp. (Hemiptera; Cicadellidae) under constant temperatures. *Florida Entomologists,* 92(1):156-158.
22. **Al-Wahaibi, A.K.** and J.G. Morse. 2009. The egg stage of Homalodisca vitripennis (Germar) and H. liturata Ball (Hemiptera: Cicadellidae): ovometrics, embryonic development, and non-parasitic mortality. *Ann. Entomol. Soc Am.* 102(2):241-248.
23. **Al-Yahyai, R., F. Al-Said** and **L. Opara.** 2009. Fruit growth characteristics of four pomegranate cultivars from northern Oman. *Fruits* 64(6): 335-341.
24. Amin, S.M., A. Arshad, B. Japar, S. Siraj and **S. Goddard**. 2009. The reproductive biology of the Sergestid shrimp, *Acetes indicus*, (Decapoda : Sergestidae) in the coastal waters of Malacca, Peninsular Malaysia. *Zoological Studies* 48(6):753-760.
25. **Basunia, M.A.** and T. Abe. 2009. Performance of a mixed-mode type solar crop dryer in drying rough rice under natural convection. *Agricultural Mechanization in Asia, Africa and Latin America*, 40(3), 23-29.

26. Bhatt, N., M. Singh and **A. Ali.** 2009. Effect of feeding herbal preparations on milk yield and rumen parameters in lactating crossbred cows. *International Journal of Agriculture and Biology* 11:721-726.
27. **Boughanmi, H., M. Mbaga** and **H. Kotagama.** 2009. The effects of regional trade arrangements on agri-food trade: An application of the gravity modeling approach to the Arab Gulf Cooperation Countries. Review of Middle East Economics and Finance, 5(3) Article 3. Available at: http://www.bepress.com/rmeef/vol5/iss3/art3
28. Chen, S., B.Z. Lin, M. Baig, B. Mitra, R.J. Lopes, A.M. Santos, D.A. Magee, M. Azevedo, P. Tarroso, S. Sasazaki, S. Ostrowski, **O. Mahgoub,** T.K. Chaudhuri, Y. Zhang, V. Costa, L.J. Royo, F. Goyache, G. Luikart, N. Boivin, D.Q. Fuller, H. Mannen, D.G. Bradley and A. Beja-Pereira. 2009. Zebu cattle are an exclusive legacy of the South Asia Neolithic. *Molecular Biology and Evolution. Advance Access* published September 21, 2009.
29. **Dobretsov, S.**, M. Teplitski and V. Paul. 2009. Quorum sensing in the marine environment and its relationship to biofouling. *Biofouling* 25(5):413 – 427.
30. Eremeev, V.N., **S.A. Piontkovski,** N.A. Jukov and N.A. Sizov. 2009. Coupling between interannual fluctuations of the sea surface temperature and zooplankton biomass in the Tropical Atlantic Ocean. *International Journal of Environmental Studies* 66(5):539-546.
31. **Esechie, H.A.** and S.M. Al-Farsi. 2009. Performance of elite pearl millet genotypes under salinity stress in Oman. *Crop Research* 37:28-33.
32. **Esechie, H.A.** and S.A. Al-Hinai. 2009. Morphological and agronomic variation in alfalfa (*Medicago sativa* L.) germplasm in Oman. *Crop Research* 10:378-384.
33. **Esechie, H.A.,** S.A. Al-Hinai and A. Hadj-Hassan. 2009. Evaluation of genetic diversity in local Omani alfalfa (*Medicago sativa L.*) germplasm with RAPD markers. *Crop Research* 37:195-202.
34. **Henderson, A.C**., J.L. McIlwain, H. Al-Oufi, **S. Al-Sheili** and **N. Al-Abri.** 2009. Size distributions and sex ratios of sharks caught by Oman's artisanal fishery. *African Journal of Marine Science* 31:233 – 239.
35. Iqbal, S., **M. Al-Ani,** J. Al-Zadjali, Z. Al-Abri and **B. Al-Belushi.** 2009. Assessment of reference values for selected plasma

nutrients of healthy university students in Oman. *Journal of Medical Sciences* 9(2):81-86.

36. Ji, L. A. Chauhan, J. Wegiel, **M.M. Essa** and V. Chauhan. 2009. Gelsolin is proteolytically cleaved in the brains of individuals with alzheimer's disease. *Journal of Alzheimers Disease* 18(1):105-111.
37. **Johnson, E.H., K. Al-Habsi** and **R. Al-Busaidi.** 2009. Comparative chemiliminescence responses of ovine neonatal and adult polymorphonuclear leukocytes. *Veterinary Immunology and Immunopathology* 134:265-268. Epub 2009.
38. **Johnson, E.H**., **K. Al-Habsi** and **R. Al-Busaidi.** 2009. The effects of low levels of dietary cobalt on the oxidative respiratory burst of caprine polymorphonuclear leukocytes. *Research in Veterinary Science* 88(1):61-63. Epub2009.
39. **Kacimov, A.R.**, F. Marketz and T. Pervez. 2009. Optimal placement of a wellbore seal impeding seepage from a tilted fracture. *Applied Mathematical Modeling* 33(1):140-147. DOI 10.1016/j.apm.2007.10.027.
40. **Kacimov, A.R.,** M.M. Sherif, J.S. Perret and A. Mushikhi. 2009. Control of sea water intrusion by salt water pumping: Coast of Oman. *Hydrogeology Journal* 17(3):541-548. DOI 10.1007/ s10040-008-0425-8.
41. **Kacimov, A.R.** 2009. Minimal-seepage depth of isobaric cavity under ponded conditions. *Journal of Irrigation and Drainage,* ASCE, 135(1):108-110.
42. **Kacimov, A.R.**, **S.A. Al-Jabri,** M.M. Sherif and S. Al-Shidi. 2009. Slumping of groundwater mounds: Revisiting the Polubarinova-Kochina theory and modeling by analytic element method. *Hydrological Sciences Journal*, (Institute of Hydrology, UK), 54(1):174-188.
43. **Kacimov, A.R**. and E. Youngs. 2009. Axisymmetric critical cavities for water exclusion in "Green and Ampt" soils - use of Pologii's integral transform. *Journal of Engineering Mathematics* (Springer), 64(2):105-112.
44. **Kacimov, A.R.**, F. Marketz and T. Pervez. 2009. Analytical solutions for one-phase seepage flows impeded by wellbore seals. *Journal of Petroleum Science and Engineering* (Elsevier), 64 (1-4):67-76, DOI:10.1016/j.petrol.2008.12.005.
45. **Kadim, I.T**., B.H.A. Al-Qamshui, **O. Mahgoub**, **W. Al-Marzooqi** and **E.H. Johnson.** 2009. The effects of ascorbic acid and seasonal temperatures on meat quality characteristics of

broiler chickens maintained in open-sided and closed houses. *International Journal of Poultry Science* 8:733-739.

46. **Kadim, I.T.**, **O. Mahgoub, W. Al-Marzooqi, S. Khalaf**, S.S. Al-Sinawi, S.M. Al-Lawati and I.S. Al-Amri. 2009. Effect of transportation during the hot season and low voltage electrical stimulation on histochemical and meat quality characteristics of sheep *Longissimus* muscle. *Livestock Science* 126:154-161.
47. **Kadim, I.T., O. Mahgoub, W. Al-Marzooqi, S. Khalaf**, S.S. Al-Sinawi, I.S. Al-Amri, and **M.H. Mansour**. 2009. Effects of electrical stimulation on histochemical muscle fibre staining, quality and composition of camel and cattle *Longissimus thoracis* muscle. *Journal of Food Science* 74:S44-S52.
48. **Kadim, I.T.,** Y. Al-Hosni, **O. Mahgoub, W. Al-Marzooqi**, **S.K. Khalaf**, S.S.H. Al-Sinawi, A.M. Al-Lawati and I.S. Al-Amri. 2009. Effect of low voltage electrical stimulation on post mortem biochemical and quality characteristics of Longissimus thoracis muscle from one-humped camel (*Camelus dromedaries*). *Meat Science* 82:77-85.
49. **Kadim, I.T., O. Mahgoub, W. Al-Marzooqi,** and **S. Khalaf.** 2009. Effect of low voltage stimulation and splitting the carcass on histochemical and meat quality characteristics of *Longissimus thoracis* muscle from the one-humped camel (*Camelus dromedaries*). *Journal of Camelid Science* 2:30-40.
50. Kavvadias, K.C., V.Z. Maroulis, M.K. Krokida and **M.S. Rahman.** 2009. Development of a versatile database for transport properties of foods. *International Journal of Food Properties* 12(3):522-535.
51. **Mahgoub, O., I.T. Kadim** and M. Robinson. 2009. An evaluation of goat husbandry systems and feed resources on the Saiq plateau, Oman. *Al-Jabal Akhadar Monogram*. Reginald Victor and Michael Robinson (Editors).
52. **Mothershaw, A.S**., T. Gaffer, **I.T. Kadim. N. Guizani**, I. Al-Amri, **O. Mahgoub** and S. Al-Bahry. 2009. Quality characteristics of broiler chicken meat on salt at different temperatures. *International Journal of Food Properties* 12:681-690.
53. Ohashi, A., **F.A. Al-Said** and I.A. Khan. 2009. Evaluation of different muskmelon (*Cucumis melo*) cultivars and production systems in Oman. *International Journal of Agriculture and Biology* 11:596–600.
54. **Opara L.U., M.R. Al-Ani** and Y.S. Al-Shuaibi. 2009. Physico-chemical properties, vitamin C content and antimicrobial

properties of pomegranate fruit (*Punica granatum* L.). *Food and Bioprocess Technology* 2:315-321: DOI 10.1007/s11947-008-0095-5.

55. **Piontkovski S.A**. and C. Castellani. 2009. Decline of zooplankton biomass in the tropical Atlantic Ocean. *Hydrobiologia* 632:365-370.
56. **Rahman, M.S**. 2009. Food stability beyond water activity and glass transition: Macro-micro region concept in the state diagram. *International Journal of Food Properties* 12(4):726-740.
57. **Rahman, M.S., R.M. Al-Belushi**, **N. Guizani,** G.A. Al-Saidi and **B. Soussi**. 2009. Fat oxidation in freeze-dried grouper during storage at different temperatures and moisture contents. *Food Chemistry* 114:1257-1264.
58. **Rahman, M.S.** and A.I. Al-Mahrouqi. 2009. Instrumental texture profile analysis of gelatin gel extracted from grouper skin and commercial (bovine and porcine) gelatin gels. *International Journal of Food Sciences and Nutrition* 60(S7):229-242.
59. **Rahman, M.S**. Q. Al-Shamsi, Q. Bengtsson, S. Sablani and **A. Al-Alawi**. 2009. Drying kinetics and allicin potential in garlic slices during different methods of drying. *Drying Technology* 27(3):467-477.
60. **Rahman, M.S.**, W. Senadeera, **A. Al-Alawi**, T. Truong, B. Bhandari and G. Al-Saidi. 2009. Thermal transition properties of spaghetti measured by Differential Scanning Calorimetry (DSC) and Thermal Mechanical Compression Test (TMCT). *Food and Bioprocess Technology*, On line (2009).
61. Richardson, P.B., M.W. Bruford, M. Calosso, L.M., Campbell, W. Clerveaux, A. Formia, B.J. Godley, **A.C. Henderson**, K. McClellan, S. Newman, K. Parsons, M. Pepper, S. Ranger, J.J. Silver, L. Slade and A.C. Broderick. 2009. Marine turtles in the Turks and Caicos Islands: remnant rookeries, regionally significant foraging stocks, and a major turtle fishery. *Chelonian Conservation and Biology* 8:192-207.
62. Rushdi, A.I., K.F. Al-Mutlaq, B.R.T. Simonei, **A.R. Al-Azri,** A. DouAbul, S. Al-Zarban and F. Al-Yamani. 2009. Characteristics of lipid tracer compounds transported to the Arabian Gulf by runoff from rivers and atmospheric dust transport. *Arabian Journal of Geosciences*. 3(2):113-131. DOI. 10.1007/s12517-009-0043-3
63. Sanjika, T.M., **H.P.W. Jayasuriya** and V.M. Salokhe. 2009. Effect of spray nozzle type and crop canopy on spray

deposition. *Botswana Journal of Agriculture and Applied Sciences,* ISSN 1815-5574, 5(1):95-100.

64. Sreekumar, R., **Z. Al-Attabi**, H.C. Deeth and M.S. Turner. 2009. Volatile sulphur compounds produced by probiotic bacteria in the presence of cysteine or methionine. *Applied Microbiology. Letters in Applied Microbiology* 48:777-782.
65. Strack, O.D.L. and **A.R. Kacimov**. 2009. Application of mathematics to flow in porous media before the computer age; an introduction to the Special Issue "Applying mathematics to flow in porous media". *Journal of Engineering Mathematics (*Springer), 64(2):81-84. DOI 10.1007/s10665-009-9289-8.
66. Tahri, T., S.A. Abdul-Wahab, A. Bettahar, M. Douani, H. Al-Hinai and **Y. Al-Mulla**. 2009. Simulation of the condenser of the seawater greenhouse. Part I. Theoretical development. *Journal of Thermal Analysis and Calorimetry* (96)1:35-42.
67. Tahri, T., S.A. Abdul-Wahab, A. Bettahar, M. Douani, H. Al-Hinai and **Y. Al-Mulla**. 2009. Simulation of the condenser of the seawater greenhouse. Part II. Application of the developed theoretical model. *Journal of Thermal Analysis and Calorimetry* (96)1:43-47.
68. Tahri, T., S.A. Abdul-Wahab, A. Bettahar, M. Douani, H. Al-Hinai and **Y. Al-Mulla.** 2009. Desalination of seawater using a humidification–dehumidification seawater greenhouse. *Desalination and Water Treatment* 12:382–388.
69. **Zekri, S.** 2009. Controlling groundwater pumping online. *Journal of Environmental Management* 90:3581–3588.

Book

1. **Rahman, M.S.** (Editor) 2009. Food Properties Handbook, Second Edition, CRC Press, Boca Raton, FL (USA), 24 Chapters, 861 pages.

Book Chapters

1. Ahmed, J. and **M.S. Rahman**. 2009. Thermal Conductivity Data of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 521-581. CRC Press, Boca Raton, FL.

2. Ahmed, J. and **M.S. Rahman**. 2009. Thermal Conductivity Measurement of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 519-545. CRC Press, Boca Raton, FL.
3. **Al-Azri A.R., S.A. Piontkovski, K.Al-Hashmi,** J.I. Goes and H.R. Gomes. 2009. Recent Outbreaks of Harmful Algal Blooms Along the Coast of Oman: Possible Response to Climate Change? In: *Indian Ocean Tropical Cyclones and Climate Change*. Charabi Yassine (Editor). Springer, 285pp. DOI 10.1007/978-90-481-3109-9_39.
4. Deth, R., C. Muratore and **M. Waly**. 2009. Oxidative Stress in Autism. In: *The Neurochemical Basis of Autism*. pp 185-199. Springer ISBN 9781441912718, 2009.
5. **Dobretsov, S.** 2009. Expected Effect of Climate Change on Fouling Communities and its Impact on Antifouling Research. In: *Advances in Antifouling Coatings and Technologies*. C. Hellio, D.M. Yebra (Editors), pp 222-240. CRC Press, USA.
6. Michailidis, P.A., M.K. Krokida, G.I. Bisharat, D. Marinos-Kouris and **M.S. Rahman.** 2009. Measurement of Density, Shrinkage, and Porosity. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 383-397. CRC Press, Boca Raton, FL.
7. Michailidis, P.A., M.K. Krokida and **M.S. Rahman**. 2009. Data and Models of Density, Shrinkage, and Porosity. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 399-417. CRC Press, Boca Raton, FL.
8. Michailidis, P.A., M.K. Krokida and **M.S. Rahman.** 2009. Surface Heat Transfer Coefficient in Food Processing. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 719-759. CRC Press, Boca Raton, FL.
9. **Piontkovski, S.A.** and **A. Al-Azri**. 2009. Influence of a Tropical Cyclone GONU on Phytoplankton Biomass (chlorophyll a) in the Arabian Sea. In: *Indian Ocean Tropical Cyclones and Climate Change*. Charabi Yassine (Editor). Springer, 285pp. DOI 10.1007/978-90-481-3109-9_39.
10. **Rahman, M.S.** 2009. Food Properties: An Overview. In: *Food Properties Handbook*. Rahman, M.S. (Editor), pp 1-8. CRC Press, Boca Raton.
11. **Rahman, M.S.** and S. Sablani. 2009. Water Activity Measurement Methods of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 9-32. CRC Press, Boca Raton, Fl.
12. **Rahman, M.S.**, M. Machado-Velasco, M.E. Sosa-Morales and J.F. Velez-Ruiz. 2009. Freezing Point: Measurement, Data, and

Prediction. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 69-153. CRC Press, Boca Raton, FL.

13. **Rahman, M.S.** 2009. Prediction of Ice Content in Frozen Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 155-193. CRC Press, Boca Raton, FL.
14. **Rahman, M.S**. 2009. Glass Transition Data and Models of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 209-247. CRC Press, Boca Raton, FL.
15. **Rahman, M.S.** 2009. Shape, Volume, and Surface Area. In: *Food Properties Handbook*. pp 419-501. CRC Press, Boca Raton, FL.
16. **Rahman, M.S**. and G. Al-Saidi. 2009. Thermal Conductivity Prediction of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 583-623. CRC Press, Boca Raton, FL.
17. **Rahman, M.S.** and G. Al-Saidi. 2009. Thermal Diffusivity of Foods: Measurement, Data, and Prediction. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 625-649. CRC Press, Boca Raton, FL.
18. **Rahman, M.S.** 2009. Dehydration and Microstructure. In: *Advances in Food Dehydration*. C. Ratti (Editor), pp 97-122. CRC Press, Boca Raton, FL.
19. Singh, R.P., F. Erdogdu, **M.S. Rahman.** 2009. Specific Heat and Enthalpy of Foods. In: *Food Properties Handbook*. M.S. Rahman (Editor), pp 503-517. CRC Press, Boca Raton, FL.

Proceedings/Papers, Posters, Abstracts Presented at Conferences, Symposium, Workshops, Meetings

1. **Al-Ani, M.R.** 2009. Antimicrobial properties and vitamin C content of the peel and aril of pomegranate fruit (*Punica granatum* L.) sold in Oman. *Paper Presented at the 3rd International Symposium on Medicinal and Aromatic Plants: SIPAM 2009.* Djerba, Tunisia. 26-28 March 2009.
2. **Al-Ani, M.R. L.U. Opara**, N. Al-Rahbi and **A. Al-Mahdouri**. 2009. Fruit ripening stage affects lycopene and vitamin C content in tomatoes (*Lycopersicum esculentum*): Nutritional and clinical implications. 19th International Congress of Nutrition, Bangkok, Thailand. 4-9 October 2009.
3. **Al-Attabi, Z.,** B.R. D'Arcy and H.C. Deeth. 2009. Volatile sulphur compounds in UHT milk. *42nd Annual Australian*

Institute of Food Science and Technology Convention. Brisbane, Australia. 13-16 July 2009, p. 14. Abstract.

4. **Al-Azri, A.R., S.A. Piontkovski** and **K. Al-Hashmi.** 2009. Harmful algal blooms along the coast of Oman; A usual event? *Workshop on Marine Monitoring Buoys. Middle East Desalination Research Centre*. Muscat. 28 April 2009.
5. **Al-Azri A., S.A. Piontkovski, K. Al-Hashmi** and **S. Al-Khusaibi**. Seasonality of phytoplankton in the coastal water of Oman in relation to monsoon winds. *Paper Presented at the ASLO Meeting*. Nice, France. 25-31 January 2009.
6. **Al-Azri A., S.A. Piontkovski** and **K. Al-Hashmi.** Harmful algal blooms along the coast of Oman. *Proceedings of the First International Conference on Indian Ocean Tropical Cyclones and Climate Change*. WMO. Muscat, Sultanate of Oman. 8-11 March 2009.
7. **Al-Azri, A.R.**, J. Goes, H. Gomes, **S. Piontkovski** and **K. Al-Hashmi**. Recent outbreak of harmful algal blooms along the coast of Oman: Possible causes. *Paper Presented at GEOHAB Second Open Science Meeting on HABs 2009*. Beijing, China. 18-21 October 2009. Invited as keynote speaker.
8. **Al-Azri, A.R.**, J. goes, H. Gomes, **S. Piontkovski** and **K. Al-Hashmi.** Expansion of harmful algal blooms in the coastal water of Oman, possible causes. *Abstract Presented at SCOR Meeting*, Beijing, China. 18-21 October 2009.
9. **Al-Azri, A.R., S. Piontkovski, K. Al-Hashmi,** J. Goes and H. Gomes. Recent outbreak of harmful algal blooms along the coast of Oman: Possible link to climate change? *Paper Presented at the 2009 International Tropical Cyclone Conference.* Muscat, Sultanate of Oman. 8-11 March 2009.
10. **Al-Azri, A.R., S. Piontkovski, K. Al-Hashmi,** J. Goes and H. Gomes. The link between algal blooms in Oman water and climate change. *Abstract Presented at 2009 Oman Hydro Symposium*, Muscat, Oman. 15-18 March 2009.
11. **Al-Barwani, S.M.** and **M.R. Claereboudt.** 2009. Reproductive biology of the reef scallop Laevichlays ruchenbergerii (Pecinidae, Bivalvia) in Bandar Khyran Bay, Muscat, Oman. *Paper Presented at the Asia-Pacific Aquaculture Conference 2009*. Kuala Lumpur, Malaysia. 3-6 November 2009.
12. **Al-Busaidi, A.** 2009. Combined effect of zeolite and seawater salinity on soil composition and barley growth. *Paper Presented at a Conference on Developing New Technologies for Salt Affected Soils.* Amman Jordan. 23-24 November 2009.

13. Al-Issai, J., **A.R. Kacimov**, **M. Al-Amri** and **M. Al-Balushi.** 2009. Green roof modules with siphon-fed irrigation in Oman, International Conference on Capacity in Urban Water Management under Waste Scarcity Conditions. Muscat Sultanate of Oman. 13-15 December 2009.
14. **Al-Jufaily, S.** 2009. Workshop on capacity building for sustainable fisheries management by Ministry of Fisheries Wealth in collaboration with SQU. May 31 – June 2, 2009.
15. **Al-Marzooqi, W**., **I.T. Kadim** and **O. Mahgoub**. 2009. Ileal amino acids digestibility coefficients of fish silage, fish meal and soyabean meal in broiler chicken. *Proceedings of the 2nd Mediterranean Summit of WPSA.* Antalya, Turkey. 4-7 October 2009. p. 459-464.
16. **Al-Masroori, H.S.** and B. Shekar. 2009. Developing indicators for the assessment of sustainability of an industrial fishery: A case study of the Sultanate of Oman. *Third International Conference on Aquatic Resources "Prospects and Challenge,"* Alexandria, Egypt. 17-20 November 2009.
17. **Al-Mulla, Y.A.** and **S. Al-Adawi**. 2009. Mapping temporal changes of soil salinity in Al-Rumais region of Oman using geographic information system and remote sensing techniques. American Society of Agricultural and Biological Engineers (ASABE) *Annual International Meeting.* Paper No. 095777. Reno, NV, USA.
18. **Al-Mulla, Y.A**., **M. Al-Balushi**, M. Al-Rawahy, S. Al-Makhmary and F. Al-Raisy. 2009. Evaluation of microclimatological parameters inside a screenhouse used in arid regions. *International Symposium on High Technology for Greenhouse System.* Quebec, Canada. 14-19 June 2009.
19. Al-Rashdi, K., **M.R. Claereboudt,** S. Al-Habsi and F. Al-Ajmi. 2009. Concurring evidence of rapid sea-cucumber overfishing in the Sultanate of Oman. *International Echinoderm Conference*, Tasmania, Australia. January 2009.
20. **Al-Rawahy, S.A.** 2009. Results of the project, "Management of salt-affected soils and water for sustainable agriculture." *Paper Presented at the First Workshop of the National Strategy to Combat Salinity and Protect Water Resources from Pollution and Salinity in the Sultanate of Oman.* Organized by MA and ICBA and held at Golden Tulip, Muscat, Sultanate of Oman. 4-7 October, 2009.
21. **Al-Rizeiqi, M.H., N. Guizani, M.S. Rahman** and **J. Al-Sabahi.** 2009. Assessment of selected quality parameters of a smoked

tuna (*Thunnus albacares*) product. *Proceedings of the 6th Asia-Pacific Drying Conference* (ADC 2009). Bangkok, Thailand. pp. 141-145.

22. **Al-Sadi, A.M**, A.H. Al-Jabri, **I.H. Al-Mahmooli F.A. Al-Said** and **M.L. Deadman**. 2009. Characterization of fungal pathogens occurring in potting mixtures and organic fertilizers in Oman. *Cucurbits Symposium,* China. 21-26 September 2009.
23. **Al-Sadi, A.M., A.G. Al-Ghaithi, M.L. Deadman** and **F.A. Al-Said**. 2009. Spatial analysis of Phylogenetic and Phenotypic Diversity in *Pythium* populations from a single greenhouse. *Cucurbits Symposium,* China. 21-26 September 2009.
24. **Al-Sadi, A.M., M.L. Deadman** and A.H. Al-Hinai. 2009. Characterization of fungal pathogens associated with foliar and root diseases of major agricultural crops in Al-Jabal Al-Akhdar. In: *Mountains of the World, Ecology, Conservation and Sustainable Development*. R. Victor and M.D. Robinson (Editors), pp. 142-145. Muscat, Sultanate of Oman.
25. Al-Saidi, G., **M.S. Rahman**, A. Abdullah and **N. Guizani.** 2009. Development of state diagram of bovine gelatin by measuring thermal characteristics using Differential Scanning Calorimetry (DSC). *Proceedings of the 6th Asia-Pacific Drying Conference* (ADC2009). Bangkok, Thailand. pp. 146-150. 19-21 October 2009.
26. **Al-Wardy, M.** 2009. Soil studies in support of conservation activities in the Al-Jabal Al-Akhdar – Assessment of Soil Properties. In: *Proceedings of the Mountains of the World, Ecology, Conservation and Sustainable Development*. R. Victor and M.D. Robinson (Editors), pp. 171-175. Muscat, Sultanate of Oman.
27. **Al-Yahyai, R. F. Al-Said, A. Al-Sadi, A. Al-Wahaibi, M. Deadman, M. Al-Wardy, S. Al-Ismaily,** A. Al-Lawati, A. Al-Matrooshi and A. Al-Zidjali. 2009. *Rejuvenating lime production in Oman*. Poster Presentation (Arabic). Symposium on Agricultural Sector Sustainable Development 'Following up the implementation of recommendations.' Ibri, Oman, 3 Nov. 2009.
28. **Ali, A., B.S. Al-Belushi,** I.A. Burney and M. Al-Moundhri. 2009. Dietary and lifestyle factors and risk of non-Hodgkin's lymphoma in Oman. *Poster Presented at the AICR Annual Research Conference on Food, Nutrition, Physical Activity and Cancer,* Washington, DC, USA. 05-06 November 2009.

29. **Basunia, M.A.** 2009. Drying of mushroom using a solar tunnel dryer. *Paper Presented at the 2009 International Conference on Chemical, Biological and Environmental Engineering (CBEE).* Nayang Technology University, Singapore. *09-12 October 2009.*
30. **Boughanmi, H.** 2009. The GCC economic integration process: An econometric assessment. *International Conference on Islamic Economics and Economics Cooperation Between Islamic Countries*. Kuala Lumpur, Malaysia. 28- 29 April 2009.
31. **Claereboudt M.R.** and **A.C. Henderson.** 2009. Rapid morphometric measurement of rays (Elasmobranchii) using digital photography. *Thirteenth Annual Conference of the European Elasmobranch Association*. Palma de Mallorca, Spain. 19 - 22 November 2009.
32. **Claereboudt, M.R.** 2009. Need for actual sea surface temperature data: Case studies from coral bleaching and remotely sensed "Degrees Heating Weeks". *Workshop on Marine Monitoring Buoys*. Middle East Desalination Research Center. Muscat, Sultanate of Oman. 28 April 2009. Invited Speaker.
33. **Claereboudt, M.R.** 2009. Monitoring coral communities using video surveys. *Paper Presented at a Training Workshop on Marine Environmental Monitoring Methods*. Dubai, UAE. 15-17 February 2009.
34. **Dobretsov S.** 2009. Quorum sensing inhibitors – a new way to control biofouling. *New perspectives in marine anti-fouling research*. Gothenburg, Sweden. 18-20 November 2009.
35. **Dobretsov, S.** 2009. Malyngolide from cyanobacterium *Lyngbya* sp. inhibits LasR-based bacterial quorum sensing. *European Marine Biotechnology Conference*. Concarneau, France. 1-3 September 2009. p. 11.
36. **Essa, M.M**. 2009. Increased oxidative damage in lymphoblasts from autism: Enhanced free radical generation coupled with reduced antioxidant status. *Paper presented in American Society for Neurochemistry (ASN - 2009) 40th Annual Meeting,* Charleston Marriott, Charleston, SC, USA. 7-11 March 2009.
37. **Goddard, J.S**. 2009. Small-scale aquaculture development. *Paper Presented at the workshop entitled, "Capacity Building for Sustainable Fisheries Management."* Sultan Qaboos University, Oman. May 31-June 2 2009.

38. **Guizani, N**., G.S. Al-Saidi, **M.S. Rahman**, S. Bornaz, and **A.A. Al-Alawi.** 2009. State diagram of deglet nour dates by Differential Scanning Calorimetry. *Proceedings of the 5th CIGR Section VI International Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management*, Potsdam, Germany. 31 August-02 September 2009. pp. 975-980.
39. **Kadim, I.T., O. Mahgoub, W. Al-Marzooqi, S.K. Khalaf** and **R. Al-Maqbaly.** 2009. Effect of low voltage electrical stimulation on meat quality of the one-humped camel (*Camelus dromedaries*). *Paper Presented to the* 2nd *Conference of the International Society of Camelid Research and Development.* Djerba, Tunisia. 11-14 March 2009.
40. **Mahgoub, O., I.T. Kadim, W. Al-Marzooqi** and **S.M. Lawati.** 2009. Use of date fruits for fattening Omani goats under intensive management systems. Session 3, Feeding strategies to improve small ruminant production in the current global context. Global warming impact on sheep and goat production. *Proceedings of the 13th seminar of the FAO-CIHEAM Sub-network on Sheep and Goat Nutrition*. Leon, Spain. 14-16 October 2009. p.54.
41. **Mahgoub, O., I.T. Kadim** and M.D. Robinson. 2009. An evaluation of goat husbandry systems on Al Jabal Akhdar Mountains, Oman. In: *Proceedings of the Mountains of the World, Ecology, Conservation and Sustainable Development*. R. Victor and M.D. Robinson (Editors), p. 179-185. Muscat, Sultanate of Oman.
42. **Masroori, H.** 2009. Fisherman and his role in fisheries research. Paper Presented in a Workshop on Fisheries Researches and their Future. Ministry of Fisheries Wealth, Sur. 5-6 April 2009.
43. **Mbaga, M**. 2009. Socio-economic and demographic factors that influence fishermen's willingness to participate in insurance programs: A study of small scale fishermen in Oman. *Paper presented at the 2009 Canadian Economic Association/ Canadian Agricultural Economics Society Annual Meeting*, Toronto, Canada. 29-31 May 2009.
44. **Opara, L.U. M. Al-Ani,** S. Al-Kindi, and **F.A. Al-Said**. 2009. Lifestyle modulates the beneficial effects of pomegranate juice consumption on biomarkers of health status: evidence from a clinical trial on healthy female volunteers in the Sultanate of

Oman. *Postharvest Pacifica 2009*, Napier, New Zealand. 15-19 November 2009.

45. **Opara, L.U., F. Al-Said, R. Al-Yahyai, M. Al-Ani**, **A. Al-Mahdoury**, Y. Al-Shuaibi, and K. Awlad-Thani. 2009. Food functionality, ethnopharmacy, and economic potentials of pomegranates (*Punica granatum* L.) grown in Al Jabal Al Akhdar Mountains of Oman. In: *Proceedings of the Mountains of the World, Ecology, Conservation and Sustainable Development*. R. Victor and M.D. Robinson (Editors), p. 65-67. Muscat, Sultanate of Oman.
46. Osman, N.I.E.D., **R. Al-Busaidi** and **E.H. Johnson.** 2009. The effect of breed, sex and total plasma copper level on haematology of growing kids of three Omani goat breeds. *Proceedings of the 13th seminar of the FAO-CIHEAM Sub-network on Sheep and Goat Nutrition.* Leon, Spain. 14-16 October 2009. p. 15.
47. **Palfreman, A.** The economics of fisheries management. *Paper Presented* to Ministry of Fisheries Wealth Workshop at SQU. June 2009.
48. **Piontkovski S.A.** and **A. Al-Azri.** 2009. Influence of a tropical cyclone GONU on phytoplankton biomass (chlorophyll a) in the Arabian Sea. *Proceedings of the First International Conference on Indian Ocean Tropical Cyclones and Climate Change*. Muscat, Sultanate of Oman. WMO. 8-11 March, 2009, Muscat, Oman.
49. **Piontkovski, S.A.** 2009. Drivers of biodiversity changes in zooplankton communities of the tropical Athlantic Ocean. *DIVERSITAS Open Science Conference (DIVERSITAS OSC2).* Cape Town. 14-16 October 2009.
50. **Rahman, M.S.** 2009. Role of drying on the functionality and stability of biological materials on macro-micro region concept in the state diagram and other concepts. *Proceedings of the 6th Asia-Pacific Drying Conference* (ADC 2009), Bangkok, Thailand, 19-21 October 2009 (Keynote Speaker).
51. **Rahman, M.S**. 2009. Sustaining and promoting the high quality scientific journal. *International Workshop Management of Scientific Journal of Diponegoro University towards to International Journal.* Semarang, Indonesia. 6-7 October 2009. (Keynote Lecture).
52. Sankar, D., R. Saraswathi, **A. Ali,** Y. Uehara, S. Abe, G. Sambandam and R.M. Ramakrishna. 2009. Oxidative stress by-products, antioxidant activities, electrolytes and mineral

status in stage I and II human hypertension. *Proceedings of the 41st APACPH Conference, Celebration of 25th Anniversary of APACPH,* Taipei, Taiwan. 3-6 December 2009.

53. **Sarma, Y.V.B.** and E.P. Rama Rao. 2009. Influence of the sea surface temperature on the tropical cyclone T01B movement in Bay of Bengal – A case study. *Proceedings of Indian Ocean Tropical Cyclones and Climate Change Conference.* Muscat, Sultanate of Oman. 8-11 March 2009.
54. **Schlecht, E.**, U. Dickhoefer, U. and **O. Mahgoub**. 2009. Feeding strategies and nutrient cycling in animal husbandry systems on Al Jabal Al Akhdar. In: *Proceedings of the Mountains of the World, Ecology, Conservation and Sustainable Development.* R. Victor and M.D. Robinson (Editors), pp. 103. Muscat, Sultanate of Oman.
55. Sellborn, A., H. Fink, A. Lundgren, M. Berglin and **B. Soussi.** 2009. Human endothelial cell attachment to dendrimer-Au nanoparticle functionalized surfaces. *The 6th International Dendrimer Symposium at the Royal Institute of Technology,* Stockholm, Sweden. 14-18 June 14-18, 2009.
56. **Soussi B.** 2009. Key note: Oman Marine Biotech Cluster Project. *Invited Speaker at Hopkins International Biotech Conference,* Johns Hopkins University, MD. USA, May 2009.
57. Sreekumar, R., **Z. Al-Attabi**, H.C. Deeth and M.S. Turner. 2009. Volatile sulphur compounds produced by probiotic bacteria in the presence of cysteine or methionine. *42nd Annual Australian Institute of Food Science and Technology Convention.* Brisbane, Australia. 13-16 July 2009. Abstract.
58. Tahri, T., A. Bettahara, M. Douanib, S. Al Sulaiman, H. Al-Hinai and **Y. Al Mulla.** 2009. Desalination of seawater using solar energy in the greenhouse agriculture. *International Congress on Renewable Energy and the Environment* (CERE 2009), Monastir, Tunisia. 9-21 March 2009.
59. Victor, R., **M. Ahmed, M. Al-Haddabi** and M. Jashoul. 2009. Water quality assessments and some aspects of water use efficiency in Al Jabal Al Akhdar. In: *Proceedings of the Mountains of the World, Ecology, Conservation and Sustainable Development.* R. Victor and M.D. Robinson (Editors), p 161-171. Muscat, Sultanate of Oman.
60. **Zekri, S.** and A. Naifer. 2009. Managing groundwater: A water and electricity quota approach. *Paper Submitted to the International Conference on Water Conservation in Arid Regions*. Jeddah, Saudi Arabia. 12-15 October 2009.

Abstracts of Research Presentations (SQU Day 2009)

Oral

1. **Al-Ani, M.** Antiatherogenic characteristics of consumption of fruit and vegetables grown in Oman.
2. **Al-Mulla, Y.** Evaluation of microclimatological parameters inside a screenhouse used in arid regions.
3. **Al-Saady, N.A.** Conservation and utilization of plant and animal genetic resources in Oman.
4. **Boughanmi, H.** The effects of regional trade agreements on agri-food trade in the MENA region: Evidence from a gravity model applied to the GCC countries.
5. **ElTahir, Y.** Diagnostic investigation for detection and establishment of prevalence of Brucellosis in Oman.
6. **Govender, A.** Stock status of *Epinephelus coioides* harvested in Oman.

Posters

1. **Al-Alawi, A.** Characterization of camel milk protein isolates as nutraceutical and functional ingredients.
2. Al-Ithari, A.**,** R. Ahmed, S. Sathasivan, H.B. Vuthaluru and **M. Ahmed**. Investigations into the effectiveness of cations, fly-ash and fruit-based residues for the removal of boron from seawater.
3. Al-Jabri, A.H., **A.M. Al-Sadi, F.A. Al-Said and M.L. Deadman.** Characterization of fungal pathogens occurring in potting mixtures and organic fertilizers in Oman.
4. **Al-Rawahy, S. *et al.*** Management of salt-affected soils and water for sustainable agriculture.
5. **Al-Rawahy, S., S. Al-Ismaily and R. Al-Yahyai.** Great tomatoes despite salinity.
6. **Al-Yahyai, R., F. Al-Said,** A. Al-Said, **M. Deadman, A. Al-Wahaibi, S. Al-Ismaily, M. Al-Wardy,** A. Al-Bakry, A. Al-Zidjali, A. Al-Matrooshi and A. Al-Lawati. Rejuvenating lime production in Oman: Resolving current challenges.

7. **Basunia, M.A.,** H. Handali, **M.S. Rahman** and **O. Mahgoub.** Performance evaluation of a solar tunnel dryer for drying fishes and dates in Oman
8. **Kotagama, H.**, J. Al-Handhali, **M. Ahmed** and **M. Al-Haddabi.** Cost evaluation of desalination and sewage treatment based on plants operated at sites of Petroleum Development of Oman (PDO): A case study.
9. **Piontkovski, S., A.R. Al-Azri** and H. Al-Gheilani. Oceanic eddies, algal blooms, and fish kills along the Omani coast
10. **Soussi, B., A. Al-Wahaibi,** A. AbbasKhan, **S. Dobretsov** and P. Proksch. Antimicrobial activity of soft coral extracts from Bandar Al-Khayran in Sultanate of Oman
11. **Tageldin, M.H., E.H. Johnson, K. Al-Habsi, R. Al-Busaidi and A.A.S. Ambu-Ali**. Pathological features of *Caprine arthritis encephalitis* in indigenous goats.

Technical Reports

1. **Ahmed, M.** *et al.* 2009. Feasibility Study to Upgrade the Effluent Water Treatment and Water Disposal System at the PDO MAF Terminal in Oman. Final Report. CR/AGR/SWAE/08/01.
2. **Ahmed, M.** *et al.* 2009. Boron Pre-treatment for Seawater and Brackish Water Desalination. The Middle East Desalination Research Center (MEDRC). Muscat, Oman.
3. **Ahmed, M., H. Kotagama, M. Al-Haddabi** and M. Al-Hosni. 2009. Final report of Assessment of PDO Operated Desalination and Sewage Treatment Plants. August 2009.
4. **Al-Azri, A.** 2009. Comparative Studies of Size-Fractionated Phytoplankton Primary Productivity and Bacterial Biomass and Production in Bandar Khairan Bay, Gulf of Masira Island, Arabian Sea. Final Report. IG/AGR/FISH/06/01.
5. **Al-Said, F.** 2009. Improving Production of Vegetable Crops by Development of Stress Tolerant Germplasm and Farming Systems Research. Final Report. SR/AGR/PLNT/04/01.
6. **Al-Yahyai, R.** 2009. Physiological Responses of Date Palm to Water Stress. Final Report IG/AGR/PLNT/06/05.
7. Barnes, D. and **A. Palfreman.** 2009. Code of Practice for Financing Investment in the Small-scale Fisheries Sector. Technical Report submitted to Ministry of Fisheries Wealth, Sultanate of Oman.

8. **Basunia, M.** 2009. Performance Evaluation of Solar Tunnel Dryer in Drying Dates and Fishes in Oman. Final Report. IG/AGR/SWAE/08/01.
9. Bawaain, M.S., **M. Ahmed**, *et al.* 2009. Feasibility Study to Upgrade the Effluent Water Treatment Facility and Water Disposal System at the PDO MAF Terminal in Oman, April 2009.
10. **Boughanmi, H.** 2009. Wheat Cultivation in the Sultanate of Oman: Situation, Challenges and Prospects. Prepared with the Technical Group for the "Wheat project" and submitted to the National Committee (In Arabic).
11. **Goddard, S.** 2009. Integrated Small-Scale Tilapia Farming in Oman. Final Report. IG/AGR/FISH/04/04.
12. **Govender, A.** 2009. The Use of GCC Kingfish Data for Stock Assessment Purposes. Technical Report submitted to Ministry of Fisheries Wealth, Sultanate of Oman.
13. **Govender, A.** and J. McIlwain. 2009. Stock Status of *Epinephelus coioides* Harvested in Oman. Technical Report submitted to Ministry of Fisheries Wealth, Sultanate of Oman.
14. Hodgkiess, T., J.W. Oldfield, T. Hoepner and **M. Ahmed.** 2009. Assessment of the Composition of Desalination Plant Disposal Brines. The Middle East Desalination Research Center, Muscat, Oman.
15. **Johnson, E.H.** 2009. The Effect of Low Levels of Dietary Cobalt on Select Parameters of the Specific and Non-Specific Immune System of Omani Goats. Final Report IG/AGR/ANVS/06/01.
16. **Kadim, I.** 2009. Bioavailability of Iron in Various Types of Meats in the Sultanate of Oman. Final Report. IG/AGR/ANVS/06/02.
17. **Kotagama, H**., J. Al-Handhali, **M. Ahmed** and **M. Al-Haddabi.** 2009. Cost Evaluation of Desalination and Sewage Treatment Based on Plants Operated at Sites of Petroleum Development of Oman (PDO), Consultancy Report submitted to PDO.
18. **Opara, L.U.** 2009. Development of a Computer Controlled Cyclic Misted Forced Ventilation System for Cooling Dairy Cows. Final Report. IG/AGR/BIOR/02/01.
19. **Opara, L.U.** 2009. Postharvest Technology to Reduce Losses and Improve Quality and Supply of Fresh Produce in Oman. Final Report. SR/AGR/BIOR/05/01.

20. **Opara, L.U.** 2009. Quantification, Prediction and Reduction of Postharvest Losses of Fresh Foods in Oman. Final Report. IG/AGR/BIOR/04/01.
21. **Opara, L.U.** 2009. Utilization of Power and Machinery in Arid Agriculture. Final Report. IG/AGR/BIOR/04/03.
22. **Prathapar, S.A**., **M. Ahmed, S. Zekri, S. Al Jabri, A. Al Maktoomi**, O. Abdalla and M. Al Sheli. 2009. Managed Aquifer Recharge of Treated Wastewater in Oman: Phase I. Consultancy Report. Submitted to Haya Water, Oman.
23. **Prathapar, S.A.**, M. Bawain, A. Al Lawati, **H. Abdelrahman**, M. Tahat and J. Tangka. 2009. Oil-Production Water Disposal Issues at Sahma. Consultancy Report submitted to Petrogas LLC.
24. **Soussi, B.** 2009. Value-Added Marine Raw Materials and Health. Final Report. SR/AGR/FOOD/05/01.
25. **Zekri, S.** 2009. Policy Options for Omani Fish Exports to the GCC Countries. Final Report. AS/AGR/ECON/09/01.

Articles in Newspapers & other SQU Publications

1. **Ahmed, M.** and **S.A. Prathapar**. 2009. Feasibility of Managed Aquifer Recharge Using Excess Treated Wastewater in Oman. *SQU Magazine Horizon*, Issue 172.
2. **Al-Ani, M.R.** 2009. Tomatoes for your heart. *Al-Massar* 154. 20 January 2009.
3. **Al-Saady, N.** 2009. Report on Plant and Animal Genetic Resources. *Al-Anwar Report (Al-Watan Newspaper).*
4. **Dobretsov, S.** Bioactive Compound from Oman Soft Coral. *SQU Magazine Horizon*, Issue 179, 30 December 2009.
5. **Dobretsov, S.** SQU Researchers Isolate Bioactive Compound From Oman Soft Coral. *Oman Tribune*, 5 December 2009.
6. **Dobretsov, S.** SQU Researchers Isolate Bioactive Compound from Oman Soft Coral. *Oman Daily Observer*, 5 December 2009.
7. **Goddard, J.S.** and **A. Henderson.** 2009. Fish and Shellfish Resources of the Sultanate of Oman. *An illustrated article written for the Oman National Museum brochure.*
8. **Kadim, I.T.** 2009. Microbiological, Chemical and Environmental Contamination of Meat and Meat Products. *Oman Daily Observer*, May 2009.

9. **Kadim, I.T.** 2009. Nutritive Value of Camel Meat. *Oman Daily Observer*, May 2009.
10. **Kadim, I.T.** 2009. Effect of Low Voltage Electrical Stimulation on Meat Quality of Omani Camel. *SQU Magazine, Horizon*, Issue 164.
11. **Kadim, I.T.** and **O. Mahgoub**. 2009. Study on Camel Meat at SQU. *Oman Daily Observer,* May 1, 2009 Issue.
12. **Kadim, I.T.** 2009. Camel Meat: Food and Medicine. *Oman Daily Observer,* September 16, 2009 Issue; *Al Watan Newspaper,* September 12, 2009 Issue (Arabic).
13. **Kadim, I.T., O. Mahgou**b and **R.S. Al-Maqbali**. 2009. Detection of Melamine in Meat and Meat Products in Omani Markets. *Omani Daily Observer,* November 10, 2009 Issue; *Al Watan Newspaper,* November 10, 2009 Issue (Arabic).
14. **Kadim, I.T**. 2009. Rule of Safety and Quality of Meat on Human Balance Diet. *SQU Magazine Al Massar,* February 2009 Issue 157.
15. **Rahman, S.** 2009. SQU Academic Edits Food Properties Handbook. *Oman Tribune*, 10 November 2009.
16. **Rahman, S.** 2009. SQU Professor edits Food Properties Handbook. *Observer*, 11 November 2009.
17. **Rahman, S.** 2009. CAMS Academic Edits Food Properties Handbook. *SQU Magazine Horizon*, Issue 176, 20 November 2009.
18. **Zekri, S.** 2009. Aflaj Management and Dry-up. *Al-Watan Newspaper*. 4 July 2009.

PhD Dissertations

1. **Al-Bulushi, Ismail.** 2009. Gram-positive bacteria in sub-tropical manine fish and their mesophilic spoilage potential. *PhD thesis,* University of Queensland, Australia.
2. **Al-Ismaili, Abdulrahim.** 2009. Modelling of a humidification-dehumidification greenhouse in Oman. *PhD thesis,* Cranfield University, U.K.

Appendix

Appendix - CAMS Research Profile, 2009.

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