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PROCEEDINGS OF JAFFNA SCIENCE ASSOCIATION

ABSTRACTS - 2003

ELEVENTH ANNUAL SESSIONS

02 – 04 – April 2003

JAFFNA, SRI LANKA
2003

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This volume is a record of the proceedings of the Eleuenth Session of the Jaffna Science Association. This contains the abstracts of papers accepted for presentation at the Eleventh Annual Session of the Jaffna Science Association to be held at the University of Jaffna from 2 – 4 April 2003. It contains seven abstracts in Pure Science (Section A) twenty Three abstracts in Applied Science and Technology (Section B) and two abstracts in Medical Science (Section C).

I with to thank the chairmen of at three sections for their assistance in getting these abstracts refereed in time for presentation at this annual session.

My special thanks are due to Mrs.T.Mikunthan for her invaluable assistance in bringing this volume in time

Prof. K.Kugabalan
Chief Editor

Head, Dept. of Geography,
University of Jaffna,
Jaffna.
02.04.2003

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A study on lifecycle of *plutella xylostella* (l) (lepidoptera: plutellidae), a pest on cabbage in Jaffna, Sri Lanka

Jamuna,S. and Rajendramani Gnaneswaran

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Plutella xylostella (L) (Lepidoptera: Plutellidae) is a pest of cruciferous vegetables (Wijeratnae, 1992) and causes a serious threat to the cabbage cultivation in Jaffna.

A life cycle study of this species was studied in the laboratory at 29.5± 0.4 °C and 76.37 ±6.3% RH. Mass culture of *P.xylostella* larvae was maintained in the laboratory by keeping pupal stages collected from vegetable field in Jaffna into glass tanks covered with muslin cloth. Plenty of fresh cabbage leaves were added daily.

The adult was grayish brown moth. Both male and female are identical except in the size and the shape of the apex of the abdomen. Yellow oval eggs were laid singly or in-groups of 3-30 (N=25). Mean length and breadth of eggs were 0.473± 0.016mm and 0.369±0.014mm respectively (N=50). Incubation period and percentage of hatchability of eggs were 3 to 4 days and 96.14 ±1.12% respectively. The mean larval period was 8.2 ±0.14 days (N=20) and passed through four instars which showed distinct head capsule width.

The duration of 1^{s}, 2nd, 3rd and 4th instar larva were 1.8, 2.2, 1.95 and 2.25 days respectively. Pupation occurs on the undersurface of the leaf and stem. The mean length of pupa was 6.2 ±0.32 mm (N=50) and mean pupal period was 4.5± 0.36 days (N=18) respectively. The mean longevity of male and female moth when left together in the glass tank was 14.6 ±0.89 and 14 ±1 days respectively. Sex ratio was 1:1and preovipositional period and mean fecundity were twenty-four hours and 205 ±21.45 respectively.

The total lifecycle of *P.xylostella* ranged from 16 to 17 days in 29.5 ±0.4°C room temperature and 21 to 22 generation /year would occur in Jaffna. The short lifecycle of this pest compared to the studies of Hill (1993) and Chand (1995) provides more annual generation than reported

It is concluded that lifecycle study with distinct periods in different stages investigated in this study would give some constructive measures in control of this pest.

(N= number of sample)

Reference:

Chand,P (1950). Agricultural and forest pests and their management. Oxford and IBH Co. Pvt.ltd. 142-143.

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Assessment of non-*apis* bee pollinators (hymenoptera: apoidea) in Valigamam region, Jaffna.

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A field study was conducted for a period of August 2001 to March 2002 in five selected areas namely Tellippalai, Chunnakam, Urumpirai, Thirunelvely and Manipay - nothern part of Sri Lanka - to study the species composition of non-*Apis* bees existing in this region.

In this study eleven species of non-*Apis* bees were identified using keys (Batra, 1977 and Borrer, *et al* 1976) which belong to two families. Identified bees are *Nomia westwoodi* Gribodo and *Halictus* sp. of Family Halictidae, *Xylocopa fenestrata* (Fabricius), *Xylocopa confusa* Pereze, *Ceratina hieroglyphica* Smith, *Ceratina (Pithitis) binghami* Cockerell, *Braunsapis* sp., *Amegilla violacea* Lepeletier, *Amegilla* sp., *Thyreus histrio* (Fabricius) and *Trigona iridipennis* Smith of Family Apidae.

Braunsapis mixta and *Trigona iridipennis* were already reported from Jaffna (Wijesekara, 2001). Other nine species have also been reported from other districts in Sri Lanka (Wijesekara, 2001) but not from Jaffna district.

Host plant range of each bee was also studied by pollen analysis. In the field study during this period thirty-one plant species of eighteen families were recorded as host plants of identified bees. Our study shows that *Trigona iridipennis* has wide range of host plants of 12 families.

It is concluded from this study that among eleven species of non-*Apis* species bees in Jaffna district *Trigona iridipennis* was found to be significantly the dominant species which appears to be successful pollinator of economically important crops including fruit trees.

Reference

Batra, S.W.T (1977). Bees of India (Apoidea) their behavior, management and a key to the Genera. *Oriental Insects:* **11**(03): 289-324

Borror, D.J., DeLong, D.M. and Triplehorn, C. A. (1976). Order Hymenoptera. In: An introduction to the study of insects. Holt, Rinehart and Winsston, New York. p.617-700.

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Study on the feeding and growth of *Achatina fulica* in the laboratory.

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The giant African snail *Achatina fulica* is a pest of cultivated leafy vegetables. The shell is elongated cone shaped, varied in length. The colour is light brown with dark brown and cream bands. It is a nocturnal feeder that hides under bushes and garbages in the day. They feed on dead and living plant matters, excreta and all organic refuses. During unfavourable environmental conditions snails undergo aestivation.

The objective of this study was to investigate the feeding and growth of *Achatina fulica* under laboratorical culture condition.

Achatina fulica of different age groups with shell lengths 1 – 8 cm were handpicked from the human residences from 9th September to 11th October 2001 at Urumparai for experimental purposes.

The overall maximum feeding rate percentage of 1.2 cm – 1.5 cm shell length snail was 30.85 ± 1.15, the 2.3 cm - 2.6 cm shell length was 45.53 ± 3.65, the 3.7 cm – 4 cm shell length was 67.94 ± 3.81 and the 8 cm shell length was 83.34 ± 4.05. The accelerated increment in shell length was observed from 7th - 8th week from 3.17 ± 0.08 – 3.61 ± 0.08 cm. The accelerated increment in body weight was observed from 14th - 15th week from 20.99 ± 0.73 to 24.99 ± 0.55g.

The food conversion rate was greater in *Achatina fulica* of 8 cm shell length (75.61± 1.68) than that of other age groups.

Although a hermaphrodite animal, copulation recorded. Several batches of eggs were laid in small holes in the soil. The eggs are yellow coloured and oval shaped with a mean diameter of 4.62 ± 0.04 mm. There were 50 – 60 per clutch. The incubation period was 5 – 10 days. The eggs failed to hatch under dry soil conditions

Possibility of identifying nymphal instar stages in *Amrasca biguttula* (Ishida) (Homoptera : Cicadellidae) by head capsule width and wing bud length.

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Amrascas biguttula (Ishida) is a serious pest of Okra (*Abelmoschus esculentus*)(L) in Sri Lanka (Wijeratne 1999). Identifications of each instars are essential in pest management strategy.

Therefore a study of respective instar stages was thought to be feasible by studies of head capsule width and wing bud length.

Samples of nymphal instars were randomly collected from Okra plants in the field of 4000 m2 area during June to December 2000 and preserved in 25% alcohol. In laboratory the width of head capsule and the length of wing bud were measured to a total of 853 nymphs with ocular micrometer attached to the monocular light microscope (Koyawa).

Five nymphal instars were recognized from the frequency distribution of the data obtained, by preparing histograms and linear graphs. The results were confirmed by Dyar's rule (1890) in determining the instar stages (Daly 1985).High degree of accuracy indicated by r^2=0.9883 for mean head capsule width and r^2=0.9838 for mean wing bud length (r^2 is Regression coefficient).

However ratios calculated for the means of head capsule width and that of the wing bud length were 1.233 and 1.467 respectively and have no significance difference (p=0.05).

$$\text{Ratio} = \frac{\text{Mean Head capsule width of } n^{th} \text{ instar}}{\text{Mean Head capsule width of } n\text{-}1^{th} \text{ instar}}$$

$$\text{Ratio} = \frac{\text{Mean Wing bud length of } n^{th} \text{ instar}}{\text{Mean Wing bud length of } n\text{-}1^{th} \text{ instar}}$$

It is concluded that these morphometric characters are closely in agreement with Dyar's rule both of these two criteria can be used as the indices for identifying nymphal instars of *Amrasca biguttula* for further research works.

Reference

Daly,W.H.(1985) Insect morphometrics. Ann.Rev.Entomol.30 : 415-443.

Wijeratne,P.M.(1999) Insects feeding on plants in Sri Lanka. Plant genetic resource centre. Peradeniya. Sri Lanka.

Studies on floral morphology and assessment of fruit production in *Parthenium hysterophorus*

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Parthenium hysterophorus is an exotic plant species believed to have been introduced to Sri Lanka inadvertently by the I.P.K.F. It belongs to family Asteraceae. In Asteraceae only two types of florets are produced namely ray florets and disc florets. As regards sex disc florets are always bisexual; where as ray florets may be unisexual (female) or bisexual. It was decided to examine head of *Parthenium* to find out the floral morphology. Each head had five involucral bracts and many spathe. There were five unisexual female ray florets and many bisexual disc florets.

There are differences in opinion among researchers as regards fruit production of *Parthenium* . " An average plant can produce over 15,000 fruits" (Jayasuria,2001); " Each plant produces an average of 7000 fruits" (Rao,1987). These figures show no correlation, as such it was decided to make counts from plants in five sites to evaluate the fruit production capacity of *Parthenium hysterophorus*.

Five plants were collected at random from each of these sites and inflorescence (heads) were counted separately for each plant. Then five heads were collected from each of these plants at random and fruit counts were taken separately using stereo-microscope.

Results showed that average number of heads per plant was 1462. Average number of fruits per head was 103. Average number of fruits produced per plant per season was 150586 nearly 150000. ANOVA was performed and there is no significant difference between average number of fruits per head in different sites. From the results it is evident that exorbitant number of fruits are produced by *Parthenium hysterophorus* per season. Fruits are easily dispersed by various agents, hence *Parthenium* can become invasive weed.

Some biological aspects of *Sillago sihama* (F.)

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Sillago sihama, the pelagic type recorded from marine and brackish water coastal areas in the northern Sri Lanka had a shallow, oval or elongate body with two dorsal fins and omnivorous habit, commonly known for good nutrients as food fish in human consumption.

The dead fish samples were collected from three purchasing sites, Pasaiyoor (62), Koddadi (60) and Kalviyangkadu (49) from September 2001 to March 2002. The highest numbers in sample were reported during the monsoon month of November 2001.

8 deformed fish were noted, of the one hundred and seventy one samples ranged in standard lengths between 6.2 - 27.8cm. Out of 135 samples, 104 were males.

Sex ratio was 104 of male, 31 of female and 36 of unsexed fish. The length weight relationships revealed isometric growth the median was 3.0835.

Mean values of-Total, Fork, Standard, Head, Depth, Snout, Pre dorsal and Eye-diameter were 22.16 ± 5.45 21, 52 ± 5.27, 19.21 ± 4.81, 5.35 ± 1.33, 3.70 ± 1.01, 1.91 ± 0.55, 6.43 ± 1.60 and 1.30± 0.27 respectively.

Relationships between body measurements and standard length linear regression lines. Values of Total length, Fork length, Pre dorsal length, Head length, Snout length and Depth, the Median 1.1319, 1.0946, 0.3322, 0.2742, 0.1128 and 0.2048 respectively.

The analysis of stomach contents showed annelids (*Nereis*), shrimps, cephalopods (*Sepia*), small leaves, gastropod shells and skeletons of arthropods.

The relationship between the mean relative gut length and the body length is overall increasing relatively. The gut length of fish showed a positive increase with body length in the proportional ratio of 0.92107.

The maximum gonad index was calculated in the month of December.

In *S.sihama* the month of December, was concluded to indicate the onset of sexual spawning.

Canonical Discriminant Analytic Approach on finding Key variables in the construction of clusters – A comparison with Principal Component Analysis and Cluster Analysis

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The role of Statistics is to summarize, to simplify, and eventually to explain underlying features of the data. The prime purpose of "*Multivariate Statistical Techniques*" is to reduce the dimensionality of the data characterized by several variables observed on each individual under study. Working with a smaller number of dimensions makes interpretations and further analysis easier compared to dealing with higher dimensional raw data.

Two multivariate techniques known as '*Principal Component Analysis* (PCA)' and '*Cluster Analysis* (CA)' have been extensively used in discriminating multivariate observations and constructing homogeneous clusters. These methods are less efficient in exploring misclassification of multivariate observations and thereby reducing the overlapping of clusters (Morrison, 1990, Joseph et. al.,1998). Ordinary discriminant analysis (Linear or Non-linear) has produced low response results in some socioeconomic studies in constructing clusters (Elankumaran, 2001).

In this communication, we report the role of '*Canonical Discriminant Analysis* (CDA)' and explore its comparative efficiency in dicriminating clusters of individuals with multivariate responses. We used two case studies associated with the high dimensional multivariate survey data from the "*Jaffna Socio-Economic Health Study – 1999*" to highlight the role of CDA in comparison with PCA and CA in terms of the discriminatory power of some key variables. We also developed a discriminatory criteria on the basis of the scores of the first two canonical variates, which are functions of the key variables of the study. The case studies referred here are 'Varying Food Consumption Patterns' and 'The Socioeconomic Disparity' of families. In addition, the key variables playing the discriminatory role have also been identified.

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Joseph,F.H., Rolph,E.A., Ronald,L.T., and Willium,C.B. (1998) Multivariate Data Analysis, Fifth Edition. Prentice-Hall International, Inc.

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A survey on acquiring information from periodicals by health information users in Health Science Libraries in Sri Lanka.

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Major portion of the financial allocation of health science libraries goes on subscription of periodicals, as they are the backbone of these libraries. The paper examines the mode of access to periodicals, purpose of reading periodicals, the duration spend on periodical reading and the problems of acquiring information from periodicals by health information users in health science libraries in Sri Lanka. Questionnaire was the major research instrument employed in the study. Health Literature Library and Information Services (HELLIS) network member libraries were considered for the selection of users in the survey.

The study reveals that libraries are the main places to provide periodical literature access to the health information users in Sri Lanka. Medical practitioners read periodicals mainly for examination purpose whereas academic staff and the research officers read mainly for research purpose. As an average, majority of health professionals spends 5-10 hours per month to read periodicals. Undergraduate medical students heavily use the library but they rarely use periodicals. Usage of periodicals is mainly affected by lack of time availability rather than other listed factors in the questionnaire whereas language problem is the least factor affecting the usage of periodicals. Efficient library services should be provided to the users for the maximum use of available periodicals.

Production of α-amylase from locally isolated thermotolerant *Bacillus* strain

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The aim of this work is to produce a thermostable α- amylase from a bacterial strain. In this study a *Bacillus* strain isolated from rice broth (*Bacillus*, BR_1) was used for amylase production. The activation medium used for inoculum preparation contained (gl^{-1}) soluble starch, 2.0 and nutrient broth, 25.0. The activation medium (20ml) was inoculated with 2 loops full of the bacteria from stock culture and incubated at 45°C and pH 7.0 (100 rpm). At 16h, the temperature was increased to 50°C and incubated for 8h, (100 rpm). Inoculum (20%, v/v) was transferred into fermentation medium (pH 7.0) and incubated at 50°C. The fermentation medium contained (gl^{-1}), soluble starch, 2.0; $CaCl_2.2H_2O$, 0.005; $MgCl_2$ $6H_2O$, 0.005; $FeCl_3$, 0.005; K_2HPO_4, 2.5; KH_2PO_4, 10.0; peptone, 2.0; NaCl, 1.0; and $(NH_4)_2SO_4$, 2.0 The maximum enzyme activity of 20 Units ml^{-1} was obtained at 72h in the fermentation medium (1 Unit = μmole/minute). When the enzyme assay was done in presence of Ca^{++} (150 ppm), the phosphate present in the fermentation medium precipitated the calcium as calcium phosphate. The enzyme showed maximum activity at 85°C. The enzyme in the spent medium lost 95 and 18% of the original activity in presence and absence of calcium (150 ppm), at 30 min of incubation at 85°C. This was due to the precipitation of the enzyme in the fermentation medium in presence of calcium at 85°C. Hence in the next set of experiment different amounts of K_2HPO_4 and KH_2PO_4 (2.5 & 10.0, 1.25 & 5.0, 0.625 & 2.5 and 0.0 & 0.0gl^{-1}) were added to the fermentation medium, to find the minimum amount of the salts required for fermentation. The enzyme activity obtained was 20, 12, 3.3 and 2.4 Units ml^{-1} respectively at 72h. Hence it was decided not to decrease the salts. To the enzyme dialyzed against distilled water to remove the phosphate for 7h at 20°C Ca^{++} (150 ppm) was added, the enzyme retained 32 and 73% of its original activity respectively at 3h in the absence and presence of Ca^{++} at 85°C. To study the effect of temperature on the growth and fermentation character of BR_1, the organism was activated at 45°C and grown in the fermentation medium at 30, 42, 50 and 60°C. Maximum growth (OD_{600nm}, 1.27) was observed at 42°C while highest α-amylase activity produced was at 50°C (20.0Units ml^{-1}, 3rd day). The enzymes produced by BR_1 at 42°C and 50°C were taken and their activities at different temperatures were measured. Both enzyme samples showed maximum activities at 85°C. Therefore the growth temperature of the organism did not influence the optimum activity temperature of the enzyme.

Preliminary studies on the isolation of naringinase producing fungus

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This study was aimed in isolating naringinase-producing fungus. Naringin is a bitter substance found in some fruits and food substances, which limit the utility of these substances. Treating with naringinase can eliminate this bitter taste of naringin, and the treated food substances can be used industrially. To select a narginase producing fungus, a total of hundred and fifty fungal strains were isolated from corncob (25), palmyrah fruit fibre (25), opened naringin plate (21), sugar cane (14), house garbage (19), beetroot (25) and neem fruit (21). The fungus were cultured in naringin-agar slant, which contained (gl^{-1}) naringin, 2.0; yeast extract, 1; glucose, 5.0; and 100ml mineral solution ($ZnSO_4$. $7H_2O$, 0.7; CuSO4. $5H_2O$, 0.7 and FeSO4. $7H_2O$, 0.7). One loop of 6-day-old fungus spores was transferred to 0.2 %, (v/v) Tween - 80. Then serial dilution was done up to 10^{-4}. From the dilutions, 200µl samples were spread in naringin-agar plates. Fungal spores from each colony were selected and transferred to naringin - agar slant for storage. On 6th day, spores were washed with (0.2%, v/v) Tween - 80 and 2ml was inoculated into fermentation medium. The fermentation medium contained (gl^{-1}) naringin, 2.0; glucose, 2.0; soybean, 20; peptone, 7.0; $MgSO_4$. $7H_2O$, 0.1; KH_2PO_4, 0.5 and 100ml mineral solution. From each flask, samples were taken and assayed for naringinase activity after 6th days of inoculation. The Enzyme assay was done at 50°C and pH 5.0 with 30 minutes incubation. Out of twenty-five strains from corncob, C_3^5 gave the highest activity of 1586 Unit ml^{-1} (U = nmol min^{-1}). Among the twenty-five strains from Palmyrah fruit fibre, P_2^2 strain showed the highest activity of 1656 Unit ml^{-1}. N_2^5 strain among the twenty-one strains obtains from opened naringin plate gave the highest activity of 1638 Unit ml^{-1}. Out of the fourteen strains from sugar cane K_3^1 gave the highest activity of 1780 Unit ml^{-1}. H_2^3 strain gave the highest activity of 1620 Unit ml^{-1} out of nineteen strains from house garbage. Among he twenty-five strains from beetroot, B_1^3 gave the highest activity of 2300 Unit ml^{-1}. V_2^3 gave the highest activity of 900 Unit ml^{-1}, among twenty-one strains from neem fruit. Among the 150 strains isolated, B_1^3, the strain obtained from beetroot gave the highest naringinase activity (2300 Unit ml^{-1}). Hence kinetic studies of the enzyme in the spent medium with beetroot was studied. The crude enzyme gave zero order kinetics for 10 min. Therefore for the enzyme assay, 5 min incubation time was fixed. The optimum temperature (at pH 5.0) and pH (at 50°C) for the activity were 50°C and 5.0 respectively. The Km of the crude enzyme was 1.5 gl^{-1} naringin at pH 5.0 and 50°C. Further studies are in progress to improve the strain and to purify the enzyme.

Preliminary studies on the isolation of xylanase producing bacteria and kinetic studies of the enzyme

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This study was aimed at isolating a thermostable xylanase producing bacterial strain. From cowdung (3 samples), hot rice broth (one sample), water used in autoclave (3 samples), opened agar plate (3 samples), and beetroot peel (9 samples), a total of 19 bacterial strains were isolated. *Bacillus licheniformis M27* (CFTRI, Mysore) and *Bacillus licheniformis* (ATCC, 6346) were also used. Single colonies of the bacteria were obtained by cultivating the organisms in xylan-agar medium containing (gl^{-1}) nutrient broth, 25.0; agar, 10.0; and xylan, 2.0. To select the potential xylanase producer, single colonies from the samples mentioned above (21 samples) were selected, activated in xylan-nutrient broth medium (containing (gl^{-1}) xylan, 2.0; and nutrient broth, 25.0) at pH 7.0 and 42°C for 18h and used as inoculum. The inoculum was transferred into the fermentation medium containing (gl^{-1}) xylan, 2.0; peptone, 2.0; yeast extract, 2.5; $CaCl_2.2H_2O$, 0.005; $MgCl_2.6H_2O$, 0.005; $FeCl_3$, 0.005; K_2HPO_4, 2.5; KH_2PO_4, 1.0; NaCl, 0.1 and $(NH_4)_2SO_4$, 2.0. The fermentation was carried out at 42°C and pH 7.0, while shaking at 100 rpm. Enzyme assay was carried out at pH 6.9 and 60°C by incubating the enzyme extract with $10gl^{-1}$ xylan in 0.01M sodium phosphate buffer (pH 6.9) for 5 min. Among the strains, the strains from cow dung, hot rice broth and opened agar plate; *Bacillus licheniformis M27 & Bacillus licheniformis* (6346, ATCC) have not produced xylanase. One of the strains isolated from beetroot peel named as BR_3 produced $4040U^{-1}ml^{-1}$ xylanase activity ($U=nmolmin^{-1}$). Out of the 3 strains isolated from the water used in autoclave (AC_1, AC_2, AC_3), AC_2 and AC_3 showed 3340 and $6.16U^{-1}ml^{-1}$ xylanase activity respectively. The other strains BR_1, BR_2, BR_3, BR_4, BR_5, BR_6, BR_7, BR_8 and BR_9 from beetroot, produced 156, 450, 4040, 30, 1000, 0, 234, 500 and $560U^{-1}ml^{-1}$ enzyme. Therefore the strain BR_3 was selected for further studies. The strain BR_3 produced the maximum xylanase activity at 48h ($4040U^{-1}ml^{-1}$) in fermentation medium. The reaction time for the enzyme assay was fixed, as 05 min. Kinetic properties of xylanase obtained from BR_3 were determined. The optimum pH for the enzyme activity was 6.9 in 0.01M sodium phosphate buffer at 60°C. The enzyme showed the highest activity at 60°C and pH 6.9. An investigation of the temperature stability showed that 65% of the original activity ($3250\ U^{-1}ml^{-1}$) present when incubated at 60°C for 4h. However the enzyme was more stable at temperature and showed 72.7% of the original activity ($3564.08\ U^{-1}ml^{-1}$). The K_m value for the xylanase for xylan at pH 6.9 and 60°C was $0.125gl^{-1}$. The highest stability of xylanase was observed in 0.01M sodium phosphate buffer at pH 6.9 and 60°C. Further studies are underway to improve the organism and to increase the xylanase enzyme production.

Selection and improvement of a bacterial strain for protease production

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This study was aimed at selecting a bacterial strain and to improve the strain for protease production. Bacterial strains available in the laboratory, which were isolated from cow dung (CD) and boiled rice extract (BRE), *Bacillus licheniformis* M27 (CFTRI, Mysore) and *Bacillus licheniformis* (ATCC, 6346) were used in this studies. Single colonies of the selected bacteria were obtained by cultivating the organisms in nutrient-agar medium at 37°C for 24h. Single colonies were transferred to nutrient-agar slants and grown at 37°C for 24h. The nutrient- agar medium contained (gl^{-1}) nutrient broth, 10.0; peptone, 10.0; sodium chloride; 5.0, and bacteriological agar, 17.5. The bacterial cells grown on the slants were transferred into activation medium and incubated in shaker water bath at 42°C and 100 rpm for 18h. Both activation and fermentation media were same and contained (gl^{-1}) $(NH_4)_2SO_4$, 10.0; peptone, 4.0; glucose, 6.0; Na_2HPO_4, 8.0; KH_2PO_4, 4.0; $MgSO_4 .7H_2O$, 0.5; and $CaCl_2 . 2H_2O$, 0.02. The fermentation medium was inoculated with the activated bacteria (20%, v/v) and incubated. Strains CD, BRE, *Bacillus licheniformis* M27 and *Bacillus licheniformis* (ATCC, 6346) reached lag phase at 10.0,14.0, 8.0 and 14.0h respectively. Highest optical density (OD 610nm) values were obtained for CD, BRE, *Bacillus licheniformis* M27 and *Bacillus licheniformis* (ATCC, 6346) were 0.987, 1.087, 1.086 and 1.166 respectively. The highest protease activity ($1.54x10^3$ Unit ml^{-1}) was obtained for *Bacillus licheniformis* M27 at 48h. CD, BRE and *Bacillus licheniformis* (ATCC, 6346) gave the highest activities of $1.64x10^3$, $5.2x10^2$, $7.5x10^2$ Unit ml^{-1} respectively at 72h. Therefore *Bacillus licheniformis* M27 is the most suitable strain for further studies because it gave the highest activity at short time of fermentation than other strains. The protease activity from the bacterial strain of CD, BRE, *Bacillus licheniformis* M27 and *Bacillus licheniformis* (ATCC, 6346) showed zero order kinetics for 17.5, 180, 25 and 20 min respectively. Therefore the incubation period for the protease obtained from the different bacteria was fixed as 10min. The activities of protease from all four strains were measured at different temperature from 30 to 90°C. The optimum temperature for the activities of all four proteases was 70°C. The proteases from *Bacillus licheniformis* M27 showed optimum activity ($5.9x10^4$ Unit ml^{-1}) at pH 9.0. Protease showed the K_m value with casein as $0.118gl^{-1}$ at pH 9.0 and 70°C. The enzyme incubated at 4°C and room temperature (32°C) retained 100% of the initial activity for 20 days at pH 6.2. The enzyme incubated at pH 6.2 and 70°C lost 90% of its original activity in 10min, while that at 60°C retained 70% of its initial activity at 1h. When the enzyme was incubated with $25gl^{-1}$ casein at pH 9.0, it retained 90% of its initial activity at 70 (2h) and 60°C (4h) respectively. Further studies are in progress to improve the strain and to optimize the fermentation medium and culture conditions to increase the production of protease enzyme.

Preliminary studies on ethanol production by simultaneous saccharification and fermentation

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Ethanol production by simultaneous saccharification and fermentation is a cost effective and less time consuming method. Preliminary studies were made to optimize the conditions for liquefaction and saccharification. Soluble starch (16%, w/w) at pH 7.0 was liquefied by α-amylase (0.225KNUml^{-1}) at 90°C. After 140 min of liquefaction, the hydrolysate obtained contained 82gl^{-1} reducing sugar with a DE value of 48.6. To the liquefied starch at pH 4.0, glucoamylase (0.4AGUml^{-1}) was added for saccharification and incubated at 60°C. After 3h from the addition of glucoamylase, 148gl^{-1} reducing sugar was produced with the DE of 88.0. *Saccharomyces cerevisiae* (Fermipan, The Netherlands) was selected for this study. As the relative price of unit weight of wheat flour is cheaper and readily available, it was used in the preliminary studies. The constituents of wheat flour were analyzed and it contained 69.7% (w/w) starch and 8.1% (w/w) protein. The pH of the medium was maintained at 5.0 and incubation was carried out at 30°C with shaking at 100rpm. The sterile medium containing 16% (w/w) liquefied wheat starch (reducing sugar 50gl^{-1} and total sugar 105gl^{-1}) supplemented with yeast extract (2.3gl^{-1}) and peptone (5.0gl^{-1}), 0.4AGUml^{-1} glucoamylase was added and inoculated with *S.cerevisiae*. The biomass and ethanol produced at 28h were 2.3x10^{8}cells ml^{-1}and 35.0gl^{-1} respectively. As the ethanol production efficiency (64.9%) in the medium was not satisfactory, to improve the saccharification, different amounts of glucoamylase (332, 664 and 996μl) was added to the liquefied starch containing fermentation medium. The biomass obtained at 28h was highest (2.41x10^{8} cells ml^{-1}) in 332μl glucoamylase added medium while ethanol production was highest (39.5gl^{-1}) in 664 and 996μl glucoamylase added medium. The glucoamylase concentration of 664μl was selected for further studies because above this concentration there was no increase in alcohol production and sugar utilization. To increase the ethanol production, different concentrations of liquefied wheat starch (with 100, 150, 200 and 250gl^{-1} of total sugar) was taken and the biomass obtained (3.51x10^{8} cells ml^{-1}) and alcohol produced (82.1gl^{-1}) were highest in 250gl^{-1} total sugar containing medium at 36h. The total sugar concentration of 250gl^{-1} and 664μl of glucoamylase for saccharification were selected as optimum amount of carbon source and enzyme concentration for simultaneous saccharification and fermentation to obtain an ethanol yield of 0.5 at 36h.

Debittering of extracted lime juice

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In Sri Lanka, Lime (*Citrus acida*) is the most popular and widely consumed fruit by all races for flavouring and general culinary purposes. But because of seasonal production of lime fruit, preservation in the form of juice is an important aspect in a large-scale juice industry. In case of good quality lime juice production, the bitterness due to limonoids in variety of citrus juice is a major problem in the commercial juice industry and has significant negative impact on that. A study was, therefore, conducted to select a suitable debittering method for mechanically extracted lime juice. The debittering treatments tested were precipitation method using 0.1 % pectin, hydrolysis method using 0.4 % NaOH, solvent extraction method using 40 % vegetable oil, bitterness modulation method using 1.5 % citric acid and 3 % sucrose and a control. Among those treatments, the bitterness modulation method was selected, because, the pH of juice in the bitterness modulation method is 3.79, this is within the desired range of 3.7 to 3.9, which is the effective range of pH in neutralizing or masking the limonin bitterness. While the pH of other treatments are 4.24, 4.46, 4.17 and 4.12 respectively. The bitterness modulation method also significantly increased the Brix to Acid ratio from 0.956 to 1.134 than the other methods, which is an indicator of the low level of bitterness of lime juice.

Studies on maturity at harvest in relation to low tem-perature Storage of king coconut (*Cocos nucifera* var. *aurantiaca*).

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King coconut export is one of the expanding industry in Sri Lanka. King coconuts are exported by Sea freight and takes more than two weeks. The physicochemical property of liquid endosperm changes with maturity and storage period. King coconuts cannot be stored for more than one week at ambient temperature due to shrinkage and discolouration of orange coloured outer skin, fall of perianth and fungal attack on soft perianth region. The aim of the study was to examine the changes in physicochemical properties of different maturity stages under low temperature storage and select better maturity stage to facilitate sea freight of this commodity to overseas destinations. King coconuts at four different maturity stages (5,6,7 and 8 months old) were harvested for this study. Nuts were stored at 13.5±2 °C for 14 and 28 days. Storage trial was carried out with 20 replicates. °Brix value, pH, hydrostatic pressure and colour development (absorbance at 500nm) were measured for analysis. °Brix values of fresh nuts increased with maturity. High value was obtained in 8 months old nuts (6.20±0.34). °Brix values of 5,6 and 7 months old nuts showed higher value than initial value after 14 days cold storage while °Brix values of 8 months old nuts remained constant (6.20±14). °Brix values of all maturity stages became lower value after 28days. The pH and hydrostatic pressure increased with maturity. The pH value of 8 months old nut reached near the neutral value of 6.76±0.05. Both pH and hydrostatic pressure showed reduction with storage period. The pH of five months old nuts reached below the critical value (4.94). No colour development was observed with maturity and storage period. Maximum °Brix, pH and hydrostatic pressure were observed in 8 months old nuts where as no difference in colour (absorbance) in all maturity stages at fresh stage. °Brix values of 8 months old nuts remained constant up to 14 days under cold storage. Compare to other maturity stages 8 months old nuts got higher score in °Brix and pH after 28 days at 13.5±2 °C. So the 8 months old nuts can be harvested for export and can be stored for 28 days under cold storage at 13.5±2 °C.

Production of ethanol by simultaneous saccharification and fermentation: Endogenous proteins as nitrogen source from locally available starch based carbon sources

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This paper describes the utilization of locally available starch sources for ethanol production by simultaneous saccharification and fermentation. Normally peptone and yeast extract are added as nitrogen sources to the fermentation medium to improve the ethanol production efficiency and growth of *Saccharomyces cerevisiae*. *Saccharomyces cerevisiae* (Fermipan, The Netherlands) was selected for this study. To avoid the addition of exogenous nitrogen source, the proteins present in the carbon sources were hydrolysed using Neutrase (0.5AUml^{-1})-an endoprotease at pH 7.0 and 45°C. Starch in the carbon sources were liquefied with α-amylase (0.225KNUml^{-1}) at pH 7.0 for 4h. All the media used in the study contained 250gl^{-1} initial total sugar and 110gl^{-1} reducing sugar. For saccharification, glucoamylase (0.8AGUml^{-1}) was used and the pH of the fermentation medium was maintained at 5.0 and incubation was carried out at 30°C. Preliminary study was carried out with wheat flour. Wheat flour contained 8.1% (w/w) total protein and 0.1% (w/w) soluble protein. To the liquefied wheat starch (pH 7.0), Neutrase (10.0mlll^{-1}) was added and incubated at 45°C for 4h. This wheat protein hydrolysed liquefied starch-containing medium was used for yeast cultivation without yeast extract and peptone supplementation and control medium contained liquefied starch with 2.3gl^{-1} yeast extract and 5.0gl^{-1} peptone. Biomass obtained and ethanol produced at 36h were 2.7x10^{8} & 2.8x10^{8} cells ml^{-1} and 82.1 & 90.8gl^{-1} in control medium and Test medium respectively. These results indicated that the endogenous protein in wheat flour hydrolysed by Neutrase could be utilised instead of exogenous nitrogen source for the ethanol production. To improve the protein hydrolysis, liquefied wheat starch was treated with different concentrations of Neutrase (2.5, 5.0, 7.5 and 10.0mlll^{-1}). At 36h the biomass obtained (1.92x10^{8} cellsml^{-1}) and ethanol produced (89.7gl^{-1}) were highest in the wheat protein hydrolysed by 10.0mlll^{-1} Neutrase. As wheat is not a local product, different starch based material such as rice, corn, manioc and soybean were selected. To the above-liquefied starch based carbon sources yeast extract (2.3gl^{-1}) and peptone (5.0gl^{-1}) were supplemented. At 56h biomass (3.7x10^{8} and 3.5x10^{8}cells ml^{-1} respectively) obtained was highest in manioc and soybean containing media (98.6 and 95.3gl^{-1} respectively). Proteins in all these liquefied starch based carbon sources were hydrolysed with Neutrase (10.0mlll^{-1}). At 56h the biomass produced was highest in rice flour followed by manioc and soybean containing media (4.4x10^{8}, 3.7x10^{8} and 3.5x10^{8} cells ml^{-1} respectively) and ethanol produced was highest in corn flour followed by rice and soybean (105.0, 96.6 and 92.0gl^{-1} respectively). As the protein content in corn is 12% (w/w) and manioc is 1.3% (w/w), corn and manioc hydrolysates were mixed in different ratios (100:0, 75:25, 50:50, 25:75 and 0:100) and simultaneous saccharification and fermentation were carried out. The results indicated that the highest amount of biomass and ethanol were produced in corn flour containing medium at 56h. From the results it can be concluded that among the locally available starch based carbon sources corn flour (in suspension 38%, w/w) could be used after liquefaction (with 0.225KNUml^{-1}

Termamyl) and endogenous protein hydrolysis (with 0.5AUml^{-1} Neutrase) for simultaneous saccharification (0.8AGUml^{-1} glucoamylase) and fermentation by *S.cerevisiae*. The simultaneous saccharification and fermentation have not only had reduced the inhibition of sugar in fermentation by *S.cerevisiae* but also reduced the total time required for liquefaction, saccharification and fermentation from 85h to 67h..

Effect of pre and post harvest storage practices on yield and quality of potato in Jaffna district

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Potato is an important cash crop in Jaffna district. Its profitability reduces when the market is glutted during the harvesting season. Adopting appropriate storage practices is one of the ways to extend the period of potato supply in the local market. With this view, a field experiment was carried out at Thirunelvely during December 2001, to study the effect of pre and post harvest storage practices on the yield and quality of potato.

Mulching was adopted as a pre harvest storage practices (Ground storage). In this treatment, potato field was mulched with straw for a period of one month after maturity. In the post harvest storage treatments, harvested tubers were placed in wooden trays and stored in a ventilated condition for a period of one month. In the pre and post harvest storage treatments, tubers were harvested at weekly interval and its yield and quality were recorded.

Results of the experiment revealed that the soil temperature was reduced in mulched treatment compared to non-mulched. Minimum and maximum soil temperature in mulched treatment was 28.1° C and 33.2° C respectively; while in the non-mulched treatment it was 29.5° C and 34.4° C respectively. Mulching reduce the soil temperature by 1 to 1.5° C, which inturn helped to reduce tuber damage in the ground storage.

It was also found that in the mulched treatment tuber weight per plant was reduced from 169g to 107g in one month time while in non-mulched treatment loss of tuber weight per plant was 146g to 72g during same period. Further, the quality of potato also affected due to high soil temperature in the non-mulched treatment. In this treatment the skin of the tubers became black and started decaying, but no such changes were observed in the mulched treatment. Local pre harvest storage is possible without much reduction in the yield for a period of one month. During the post harvest storage weight loss of 1.76 % was noticed in one month.

Therefore it could be concluded that proper ground storage practices with help of mulching and post harvest storage can extend the period of potato availability in the local market by two months to fetch the high market price.

Evaluation of some insecticides in controlling the grub and adult of *Autoserica rotundata* wlk (Coleoptere: Scarabidae) attacking *Ixora* sp

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Ixora is one of the popular exporting ornamental plants, which is cultivated by many export oriented floriculture industries in Sri Lanka. *Autoserica rotundata* wlk (Coleoptera: Scarabidae) is a recently reported serious pest on *Ixora* in Sri Lanka. The adult beetle damages the apical shoot that is used as planting material of *Ixora*, as a result the export value of this crop is very much reduced.

The study was carried out to find out a suitable insecticide that would give a satisfactory control of grub and adult of *Autoserica rotundata*. Two experiments were conducted under laboratory condition to evaluate the effectiveness of insecticides against the grub and adult of *Autoserica rotundata*. Bacillus thuringiensis(Bt), Dazomet, Carbofuran, Chlorpyrifos, and Diazinon were tested against grub of *Autoserica rotundata*.

Uniform age healthy active 50 grubs were introduced in $1.5x1x0.75m^3$ each cage having coir dust, soil and compost mixture one month before the treatment to adapt to the new environmental condition. The insecticides were applied separately into each cage. After two weeks mortality percentage was recorded. Carbaryl, Permerthrin, Oxydemeton methyl, Dimethoate and Fipronil were tested against adult of *Autoserica rotundata*. Newly emerge healthy active 50 adult were used for this each experiment. The insecticides were sprayed into $2x1x1m^3$ cages containing potted *Ixora odurata* Noragrant plants and adults beetles. After two weeks mortality percentage was calculated.

In both experiments water was sprayed as control and treatments were replicated thrice. The experiments were arranged in CRD. Mortality percentage was transformed to arc sin value and statistically analyzed.

The ANOVA result of the both experiments indicated that there were highly significant differences among these tested insecticides at both 1% and 5% level. The results were further analyzed using DMRT (Duncan's Multiple Range Test).

In the experiment against grub, when comparing the treatments to control, Bt is the only treatment, which did not show significant difference with control. Considering all treatments, Dazomet caused highest mortality percentage and Bt caused lowest mortality percentage. The decreasing order of effect of insecticides was Dazomet, Diazin, Chloropyrifos, Carbofuran, and Bt.

In the experiment against adult, when comparing the treatments to control all treatment showed significant difference between each other. Considering all treatments, the highest mortality percentage was recorded in the Permethrin, and least mortality percentage was recorded in the Oxydemeton methyl. The decreasing order of effect of insecticides was Permethrin, Carbaryl, Fipronil, Dimethoat and Oxydemeton methyl.

Therefore Dazomet and Permethrin can be used to control grub and adult of *Autoserica rotundata* respectively.

Comparison of physical properties of fresh and old coir dust as amended growing media in *Livistona rotandifolia*

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Among floricultural industries, coir dust is becoming popular as growth media, alternative to peat. But near the fibre industries of Sri Lanka even more than three years old , heaps of coir dust is still left abundant. Hence a study was initiated to evaluate the old coir dust with fresh one as a component of growth medium in terms of export quality of queen palm (Livistona *rotudifolia*) and to select a suitable growing medium for the plant. The experiment was conducted in the Green Farms Ltd. At Marawila from October 1, 2001 to March 31, 2002. Nine different growing mixtures were used as treatments with different rates of dolomite applications. They are (1) Fresh coir dust, compost, cow dung, PG mix & 500 g dolomite [T1D1]; (2) Fresh coir dust, compost, cow dung, PG mix & 1000 g dolomite [T1D2]; (3) Fresh coir dust, compost, cow dung, PG mix & 1500 g dolomite [T1D3]; (4) Old coir dust, compost, cow dung, PG mix & 500 g dolomite [T2D1]; (5) Old coir dust, compost, cow dung, PG mix & 1000 g dolomite [T2D2]; (6) Old coir dust, compost, cow dung, PG mix & 1500 g dolomite [T2D3]; (7) Fresh and old coir dust, compost, cow dung, PG mix & 500 g dolomite [T3D1]; (8) Fresh and old coir dust, compost, cow dung, PG mix & 1000 g dolomite [T3D2]; (9) Fresh and old coir dust, compost, cow dung, PG mix & 1500 g dolomite [T3D3] .These mixtures were laid out in a two factor factorial in Randomized Complete Block Design (RCBD). Physical properties of medium such as porosity, moisture content and bulk density were measured. Evaluation was made at two weeks interval for export quality of plant. Fresh coir dust based medium with; 1000gm $^{-3}$ dolomite (T1D2) was found to the best medium compared with old and the combination of old and fresh. This was due to good physical parameters namely high porosity, low moisture content and bulk density of fresh one. Old coir dust may be used as growth medium by improving its physical parameters through further studies.

Screening for antimicrobial activity of some selected plants

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Use of herbal medicine to cure certain diseases is becoming popular besides the demand for western medicine. Secondary metabolites of some plant species act as antimicrobial agents. In this study ten different plant extracts were screened for the antimicrobial activity. UV sterilized crude water extracts were used for the study. Antibacterial and antifungal activities of plant extracts were assayed by agar diffusion and medium incorporation methods. Growth inhibition was evaluated by the diameter of inhibitory zone and reduced diameter of fungal growth respectively.

Growth of *Staphylococcus aureus* was inhibited by extracts of *Coscinium fenestratum, Carica papaya, Piper longum, Cinnamomum zeylanicum, Ocimum americanum* and *Areca catechu*. Growth of *E.coli* was only affected by *Carica papaya* and *Areca catechu*. Growth of *Klebsiella* sp was inhibited by *Carica papaya, Cinnamomum zeylanicum, Piper betle, Calotropis* and *Acorus calamus*. Growth of *Pseudomonas* showed sensitivity to *Carica papaya* and *Calotropis albiflora* and growth of *Bacillus* sp1 showed sensitivity to most of the plants tested and among the plants *Areca catechu* and *Carica papaya* inhibit most of the bacteria tested.

Different plant extracts showed significant inhibition (ranging20-100%) of different fungi on culture medium. *Aspergillus* showed sensitivity to almost all the plants tested except *Piper betle* and its growth was inhibited by 75%. Among the fungi tested *Fusarium* was highly inhibited by all plants with the varying inhibition percentage ranging from 30% by *O.basilicum* to 100% by *A.calamus*. The percentage of inhibition of *Penicillium* by different extracts was more than 85% but *Piper betle* did not inhibit the growth of *Penicillium*. Results were analysed using DMRT (α= 0.05).

Although the plant extracts showed antimicrobial activities, the raw plant extracts can not be used to inhibit the microorganisms under all circumstances. In addition to this how long these extracts can keep their antimicrobial property "invitro" in raw extract is also not certain. So isolation and purification of antimicrobial compounds from these extracts and further analysis is also important to get a good usage of plants as antimicrobial agents.

Studies on ' in vitro' approach grafting using seedlings of *Citrus sinensis* and *C. aurantifolia* with *C. aurantium* as rootstock

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Citrus species are propagated both by vegetative means and by seeds. Approach grafting is a method of vegetative propagation helps to develop true -to-type plants. By selecting drought resistant rootstock the grafted plants can be drought resistant.

Citrus aurantium (sour *citrus*) which is drought and disease resistant was selected as root stock in this study. This preliminary study on developing a protocol for seedling approach grafting of Orange (*C.sinensis*) and Lime (*C.aurantifolia*) with Sour *citrus* (*C.aurantium*) as rootstock was performed in tissue culture laboratory at 30 to 31°C and 70-75% relative humidity. Seedlings were raised as follows; river soil and sandy soil (1:1) was sterilized at 160°C for three hours, placed as 5cm height bed into propagator box which was lined with sterile filter paper. Distilled water was used to wet the sterile soil mixture. Seeds were collected from the fully ripened fruits, viability being short- lived, pericarp of seeds were removed and sown immediately on collection, 5cm apart & 1cm deep. Germination commenced after two weeks of sowing and continued up to three weeks. Polyembryony was observed. Sexual seedlings were selected for transplanting in small volume pots (10cm x 6cm) with same soil mixture. Hewitt nutrient solution was applied as foliar spray for two weeks old *citrus* seedlings (two in one pot; one scion variety and the other rootstock variety) were kept in propagator box. These seedlings were maintained at 30-31°C, 70-75% relative humidity and light intensity 1000- lux. Regular fungicide (Benlate 0.03%) application, watering and foliar nutrient spray was used to get healthy growth of seedlings. After one month of transplanting splice approach grafting was performed and tied with grafting tape and maintained within propagator box for two weeks and there after further two weeks in tissue culture growth room environment with the same conditions mentioned above. Then root of the scion was cut below the union and shoot of the rootstock was cut above the union. Grafting tape was removed and graft union was exposed to tissue culture growth room environment for two weeks, then these grafted seedlings were transplanted into increased volume pots (20cm x15cm) containing a mixture of soil, coarse sand, cow dung and coir dust (1:1:1:1) and maintained under polythene tent with70-80% relative humidity, 1000-lux illumination and intermittent misting.

This study revealed that the percentage germination of pericarp removed seeds of Sour *citrus*, Lime and Orange propagated in propagator box were 80%, 78% and 70% respectively. It was possible to approach graft at very young seedlings stage and to get 100% graft union success using *C.sinensis* and *C.aurantifolia* as scion and *C.aurantium* as rootstock. In future these grafted seedlings have to be transferred gradually to field conditions and the performance of these grafted seedlings have to be compared with control seedlings (i.e. seedlings used as scion) for their growth rate, yield and fruit quality.

Some quality parameters of ground water from some selected areas in Jaffna peninsula

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The population of Jaffna peninsula entirely depends on the limited ground water resources to meet all of their water requirements. Aim of this project is to analyse quality of the ground water of selected areas in the Jaffna peninsula to find out how and by how much they are polluted Only well water samples used for domestic purposes were analysed. Twenty one areas were selected for the analysis .Each selected area is further subdivided into five areas and samples were taken from these five different areas. The measurements were done in pentaplicate .Among physico – chemical properties, colour, odour, turbidity, pH, electrical conductivity, total alkalinity and the amounts of chloride, sulphate, iron, phosphate, nitrate, calcium, magnesium, sodium and potassium were analysed. The microbiological test for normal coliforms was done in water samples collected from certain areas.

Our results showed that the ground water from most areas has nitrate content in the range 10-40 ppm; only in Kondavil, Urumpirai, Valvettithurai and Velanai areas it is above safe level. However samples from Karaveddy, Thondamanary, Kodikaman, Kachcvhai, and Mirusuvil were coloured and had high turbidity an iron content .Water samples from Kachchai had slight odour ,sour taste and high sulphate content (nearly 330 ppm) whereas those form Karaveddy ,Ponnalai, and Thondamanaru areas had salty taste and high chloride (900-1000 ppm) content . The amount of chloride in other areas ranged from 300-600 ppm. The high amount of chloride in Karaveddy and Thondamanaru areas may be due to excessive usage of these wells leading to sharp down fall of ground water. In order to maintain the ground water level sea water enters the lime stone bed which contains and supports the ground water. It should be noted that the well studied at Karaveddy and Thondanaru areas are used by many families because of good quality water in these areas. Kayts, Ponnalai and Karaveddy areas showed high amounts of calcium, magnesium, sodium and potassium; electrical conductivity is also high. Water samples from Kayts, Velanai, Araly and Point Pedro areas showed high pH and total alkalinity.The amount of phosphate present in samples from most of the areas is less than 3ppm . However samples from Vaslvettithurai (~19ppm) Thodamanaru (~18ppm), Kodaddy (~12ppm) and Kachchai (~12ppm) areas showed high phosphate content indicating leaching of phosphate from upper soil layers to ground water .Samples from Kayts, Karaveddy and Ponnalai areas showed reasonable amount of calcium as well .This may create stone in the bladder. Water samples from Kurunagar and Pasaiyoor areas showed high value (>1800 per 100ml) for number of normal coliforms.

Non Government Organaizations such as GTZ functioning in Jaffna peninsula supplies drinking water to Kurunagar, Navanthurai, Kotaddy, Vaddukodai and Navatkuli, But our investigation indicated that the other areas such as Kayts, Karaveddy, Ponnalai,Kachchai, Mirusuvil and Maduvil also needs supply of good quality dinking water .In addition a monitoring program for periodical assessment of quality of drinking water should be introduced to protect and safeguard the public heath .

Measurement and evaluation of existing models in evapotranspiration

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Evaporation is an essential component of the hydrologic cycle and its accurate estimation is necessary for many hydrologic studies especially for irrigation scheduling. Irrigation scheduling requires four essential components; an estimation of the water extracted from the available root zone supply, a projected rate of depletion of the remaining soil water, an accurate measure of the water supplied by the precipitation and an accurate estimation of the water applied through irrigation. Estimation of water removal from root zone requires an accurate evapotranspiration estimate.

Several forms of evapotranspiration models have been developed and tested in local environmental condition. The objective of the study was to find the most influencing climate variable in the evaporation, evaluate the current state of the potential evaporation equations, compare the differences among empirical and actual potential evapotranspiration.

Penman - Monteith, Radiation and Blaney – Criddle empirical models were selected to calculate potential evaporation. Pan Evaporimeter was used to measure the actual potential evapotranspiration. Sunken drainage type small Lysimeters were designed and fabricated and were installed in Thirunelvely Agricultural Research field with chilli crop at four different places. Climatic data; mean temperature, wind speed, rainfall, vapour pressure and sunshine hours were received from Meteorological station, Thirunelvely, Jaffna.

Result of single regression analysis showed that acceptable correlation to all environmental variables; rainfall, maximum temperature, relative humidity, wind speed and vapour pressure except for sunshine hours. Most of the variance were explained by temperature with wind speed and relative humidity. Aerial evapotranspiration estimates with single environmental variable, temperature and wind speed models were best suited to this study area. Fitted model for mean temperature was $Y = -13.5 + 0.689X$, $R^2 = 0.61$ and for maximum temperature $y = -13.1 + 0.561X$, $R^2 = 0.49$, in which X denotes the variable and Y denotes the evaporation of the pan in mm/day. In multiple regression analysis, sunshine hours showed negative responsibility for evaporation of the pan. Out of selected models Penman – Monteith model showed best correlation with pan evaporation measured data.

Design, fabrication, and evaluation of a prototype incinerator for the production of white-paddy husk ash

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Rice husk is a by-product of the rice milling industry and, in Sri Lanka it is disposed as waste material and causing environmental pollution. Only a small fraction is used in rice mills to generate heat for the parboiling operation. Research is needed to find out a method to utilize rice husk more efficiently for thermal energy generation while the residual husk ash could be utilized for industrial purposes. Almost all husk used in parboiling and the boiling process are not fully combusted; resulting in non-uniform rice husk ash, which cannot be utilized in commercial activities. This study was carried out to develop a prototype incinerator to produce good quality rice husk ash, which has a high market demand, as a raw material for several industries.

The study was carried out at the Institute of Post Harvest Technology (IPHT) Anuradhapura. Laboratory experiments were done to investigate the physical, chemical and combustion characteristics of rice husk, which are necessary for the design of the prototype rice husk incinerator. The incinerator was designed in a manner to yield rice husk ash with minimum organic carbon. A prototype of the incinerator was fabricated and evaluated on the basis of carbon conversion efficiency, defined as the capability of the incinerator to reduce raw materials into the least carbon-containing ash residue. Quality of ash was evaluated based on the percentage of residual carbon present in the product. Design and performance parameters including air supply to the husk beds; proper temperature; and air requirement for complete burning were studied. Maintenance and repair features as well as design flexibility were also considered in the development of the incinerator. A completely randomised design (CRD) was employed to analyse the data and SAS statistical package was used for the test of significance.

The incinerator which was designed has primary as well as secondary air supplying sources in order to effect complete combustion of rice husk. Furthermore, the combustion chamber is completely enclosed by a cylindrical steel drum, in order to minimize heat losses and to attain high temperature within the chamber, for complete combustion of rice husk.

The study revealed that, the prototype incinerator, which was designed, could produce rice husk ash with less than 8% of residual carbon without any secondary processing. It burns rice husk with a carbon conversion efficiency of more than 95%.The findings of this research study will contribute to further development of efficient commercial scale rice husk incinerators.

Design fabrication and testing of solar cooker

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Two solar cookers were designed, fabricated and modified with local available materials including Pilot solar cooker [1] and modified solar cooker [2]. The modified solar cooker was the main cooker tested. Pilot solar cooker was also tested. They are inexpensive and more suitable for tropical country. This experiment was done the Department of Agricultural Engineering, Faculty of Agriculture, University of Jaffna. The basic design of the solar cooker is an octagon funnel shaped collector. The highly reflective, refractive and insulation material were used to collect and concentrate the sun's rays and retain heat. The collector walls were at a 60^0 angle with respect to horizontal. The inner tray was made by black metal plate to efficient conversion of sunlight to heat energy. Single factor experiment was carried out in CRD (Complete Randomized Design) with 3 replicates to select suitable material for reflector, refractor and insulator. The first factor was reflecting material of flat mirror, silver paper and gift paper. Second factor was reflecting material of smooth glass and rough glass. The next factor was insulating material of glass wool, even crumpled newspaper; wooden chips and paddy husk, by combination of the above three factors 24 treatment were performed. Finally single factor experiment was also carried out in CRD with three replicates to decide reasonable tracking interval of solar cooker. In this experiment, factor was tracking interval of 15, 30, 45, 60 and 120 minutes. The results shows that silver paper, smooth glass and crumple newspaper were suitable as reflector, refractor and insulator respectively and treatment of 45 minutes was reasonable for tracking interval. The achievable maximum air temperature of cooking vessel of solar cooker was 205^0C. The achievable maximum metal tray temperature of solar cooker was 245^0C.

Fabrication and evaluation of Groundnut decorticator

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Groundnut is one of the famous energy resources and a snack food in Sri Lanka. It is consumed directly or used for oil expelling. Shelling process of groundnut is a vital factor as it requires intensive manual labour. A groundnut decorticator was fabricated with locally available materials and tested for continuous processing. The oscillating mechanism and a blower rotating mechanism were used to design the machine. The machine consisted of a frame, hopper, semi-circular drum shelling unit, separating unit and a collector. A reciprocal motion was used to create a shear force between curved wooden block with guarded ribs and concave perforated metal screen.

Hulling unit has the perforation of 9 to 10 mm diameter (0.636 to 0.785 cm^2) and it was found as the best diameter for separation of shelled and unshelled groundnuts. The LSD results revealed that the combination of clearance 12 mm, rib 5 in number and peripheral speed 3.5 m/s is the optimum to obtain a higher percentage of head kernels. Separation efficiency was increased significantly with decreasing blower speed with the combination of reducing the inlet area. Inlet area of 160 cm^2 and rpm of 1350 were selected for better output. The results showed a kernel breakage of 4.51 + 0.68 % and separating efficiency of 95.6 + 0.43 % with feeding rate of 78 kg/hr. Test runs were conducted at the unshelled groundnut storage moisture content of 8.13 % on dry basis.

An Electronic Book for Solid Geometry

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An electronic book, which includes graphical animations and sound in addition to text and pictures as in a conventional textbook, provides a better learning experience to students. We have designed an electronic book for Solid Geometry. Solid Geometric shapes are represented as dynamic three-dimensional objects to explain the subject clearly and unambiguously, which is difficult with textbooks or boards.

To explain Solid Geometry principles animated figures, audio clips and text format are used. Facilities are provided to the user to control the animation of figures, and voice explanation. The user, for example, can change the view of the figure, and stop or replay the voice output.

This e-book is a useful reference and guide to the students to understand basic Solid Geometry. Also; it can be a prototype for an e-book on any subject. Within its scope this project is a successful one.

A Prototype System for Grammar Checking of Tamil Sentence

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In the current era of information technology, researches are going on to make computers converse with human beings in natural languages. For any analysis of the sentences one fundamental checking remains very essential – that is the syntax checking. We have built a system to check the syntax of Tamil sentences given as text input, and it is built based on the Tamil grammar represented in the form known as BNF form.

We have confined ourselves to draw a line in grammar yet to include a reasonable forms of syntaxes with which quite a number of sentences depending on the volume of databases of nouns and root verbs one can store in the computer can be formed from verbless /nounless sentences to sentences with all frequent part-of-speeches: subject, predicate, adjective, adverb, postpositions, determiner etc.

The system is built to take Tamil sentences as input and to check whether they conform to the grammar (specification) built-in to the system. If the syntax analyser finds that the sentence does not comply with any grammar rule, the system reports an appropriate error. Also, the system has identified parts of the speech of the sentence with its tense as appropriate. This information would be useful to exact answer to any query which can be made of the sentence. Thus, the system is a successful one within its scope.

Demand for Cheese in Norway

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The percapta consumption in Norway has increased from 1972 to 1995 for different types of cheese and different types of cheese are introduced into the Norwegian market over the years. Now, mainly 15 different types of cheese are consumed in Norway. All these cheeses can be classified into three different groups such as standard cheese, speciality cheese and brown cheese. Many studies have used AIDS, or linear approximation LAIDS, to obtain price and income elasticities for food commodities. This analysis is performed on a more aggregate level of goods. In this study, dynamic elements have been incorporated.

Producers are facing difficulties in planning their production level because the actual value of price elasticities and income elasticity are not available for their products. Main objective of this study is to estimate the price elasticities and income elasticity for different types of cheese in Norway.

Time series data in quarter year basis from 1977 to 1993 for 15 different types of cheese from Norwegian market were used for this analysis. The data were aggregated into three groups. It is assumed that types of cheese in each group are near substitutes and the result for the group as whole can be used to describe one individual type. The groups are Standard cheese, Speciality cheese and Brown cheese. The data set contains 73 observations of prices and quantities. The weighted average of prices was used for the each group. The AIDS model was developed to analyze the demand for cheese in Norway by non linear seemingly unrelated regression procedure. The nonlinear seemingly unrelated regression procedure of Shazam was used for this estimation. This method is iterative and converges to a maximum likelihood estimator. Each model is tested for homogeneity and symmetry and is imposed . First and second order Breusch Godfrey(BG) test was used to test autocorrelation. Misspecification of functional form is tested by RESET test and normal distribution of residuals is tested by Jarque Bera(JB) test.

All own price elasticities are negative and significant. Own price elasticities for standard cheese, speciality cheese and brown cheese are – 1.0094, -0.82866 and – 1.1144 respectively. Cross price elasticities of all the cheese are positive. This shows that they are substitutes for each other. Many of the cross price elasticities are significant except cross price elasticities between standard cheese and brown cheese. The expenditure elasticities are positive as expected and significant. Expenditure elasticities for standard cheese, speciality cheese and brown cheese are 1.121, 0.97546, 0.67039 respectively. These expenditure elasticities show that brown cheese is not more luxuries good than standard cheese and speciality cheese.

Cyclical Effect of Lagged Price on Red Onion Production in Sri Lanka

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In Sri Lanka, onion is one of the high value minor food crops. Each family spends nearly 1.8 % of their monthly income on onions. Up to the recent past cultivation of red onions was confined to the Jaffna district.

Because of the cyclical effect of lagged price on onion production, farmers are affected drastically and face difficulties in making their production decisions. It is therefore the study aim to identify the cyclical effects of lagged price on onion production in Sri Lanka.

This assessment is predominantly based on secondary data. Production (MT) and wholesale prices (Rs/Kg) were collected from the year 1980 – 2001from Statistical Abstract and Annual Reports of the Central Bank of Sri Lanka. The Koyck lag model was developed by using the ordinary least square method. The koyck lag model is originally an infinite distributed lag model.

This model contains stochastic explanatory variable (lagged dependent variable) and this model explicitly includes serial correlation. So ordinary least squares for this model will yields biased and inconsistent estimators. Therefore, the extent of onion cultivation was used as an instrumental variable to obtain consistent estimators. This variable is highly correlated with the lagged dependent variable but uncorrelated with the error term.

The study revealed that the alternation of positive and negative signs of coefficients for lagged prices indicate that the effect of lagged prices on onion production take a cyclical pattern. The influence of last year's price on the current production is higher than the previous lagged prices.

Finally the study concludes that the cyclical effect of lagged prices on onion production indicates that an increase in last year's price will increase current production. Thus, this will lower the current price for onions when there is no change in the demand for onions.

Creeping eruption among Nallur temple devotees during 2001 & 2002

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During August 2001, devotees of Nallur temple who paid their vows by performing "side roll" (Tamil "pirathaddai") were severely infected with dog's hook worm (*Ancylostoma caninum*). Among the total devotees (1014), 272 (26.8%) were effected. Among the victims, 67 (24.6%) had to seek treatment at the skin clinic, Teaching hospital, Jaffna. The clinical symptoms included red elevation of the skin (papules), itchy red zigzag lines and blisters. The main cause of the infection was suspected to be the contamination of sand, spread around the temple with dog faecal matter. Analysis of dog faecal matter, around temple and sand samples revealed the presence of parasitic eggs. Histological observations of the lesions showed inflammatory cells but no larvae. Precautionary measures were made to minimize the condition during 2002. In year 2002, sand was collected from areas uncontaminated with dog faeces, spread and sprinkled with water to allow hatching of parasite eggs. Then sand was dried in direct sunlight to kill the larvae and subsequently spreads around the temple. The infection rate was 19.6% (258) out of 1319 devotees and the patients attended the skin clinic was 9.3% (24). These results indicated a reduction of 7.5% of infection. For further reduction, the need of more comprehensive and strong preventive measures such as collection of sand, from dog's faecal contamination free area, preventing the dogs entering the area where the sand is going to be treated and spread and deworming the dogs living in the surrounding of the temple, are essential.

Major Factors influencing the dietary patterns of the people of Jaffna Society - A Factor Analytic Approach

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Food consumption patterns are undergoing substantial changes in many countries as economic development proceeds. Food insecurity, food deprivation, and famine some common phenomena in some developing countries. In the Jaffna peninsula of Sri Lanka the food consumption patterns have been terribly affected due to the ethnic conflicts and civil war during the last two decades (Elankumaran, 2001). This is more severe during the last decade. A cross-sectional study named "Jaffna Socio-Economic Health Study – 1999" reveals that there is much variation in the food consumption patterns among the society.

Altogether a sample of 1172 families was drawn from the Valikamam sector of the Jaffna peninsula by a two-stage cluster sampling technique. The data collected by a pre-designed questionnaire included information of demographic nature, monetary status and food consumption patterns of families. The weekly consumption of seventeen major food items and the converted daily nutrient intakes were subjected to data analysis. Factor analysis (FA) was employed on income-expenditure data and food consumption data to extract the results in terms of common causes affecting the food consumption patterns among the families.

FA employed on monetary status of families produced '*Effective income as controlled by non-health expenditure and food subsidy*' as main factor of monetary status influencing food consumption. Further FA employed on the data of weekly consumption produced eight important factors. The consumption of '*Rice, Rice flour, Wheat flour, Pulses and Coconuts*' was identified as the first important factor. The second factor was the consumption of '*Sea food, Meat, and Eggs*'. Though these two factors explain about 21% of the variation, it appears that there exist two extreme groups of families. They are namely those consume '*more of the food items characterized in the first factor*' and '*less of these but more of the other food items*'. Also there is a middle group which uses a nominal amount of the food items.

Other six factors, which explain low percentage of variations, were also suitably identified and named. In addition four socio-economic classes were also constructed. Hence any rehabilitative process to improve the nutritional supplement in the poor socio-economic class should be based on this consumption process.

Reference

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Drawing Chemical Structures of Inorganic Compounds From Their Molecular Formulae Using Java

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Molecular structures are useful to express the interpretations in Inorganic Chemistry. We have built a system to draw structures of Inorganic chemicals deriving from their molecular formulae. This involves grammar definition, syntax checking, format checking, semantic checking and drawing three-dimensional structure of the chemical. The platform-free object oriented language Java is used to implement the system.

On receiving the input from the user as a plain text, the system checks whether the formula complies with the grammar defined. If it doesn't comply, an appropriate message will be displayed. If it conforms to the grammar, the formula is split into several components as appropriate in order to extract the semantic of the formula. Semantically incorrect formula will be rejected with the appropriate message. Once the formula is found to be error free, the split components and their configurations will be identified and represented in a form, which the system will use for drawing. The structure is drawn in three-dimension. The necessary data needed for identifying the three dimensional configurations are built-in to our system. The built-in data are utilised appropriately for the respective formula that the user gives to the system.

The system is a successful one within its scope, and it is useful to students as well as to teachers who teach Inorganic Chemistry. It can be useful even to researchers for verification of any newly found Inorganic chemicals.