# Technical Session - Export Agriculture

## Table of Contents

## Oral Session

## Poster Session

# *In vitro* antifungal activity of selected medicinal plant extracts against selected postharvest pathogens in fruits and vegetables

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## Introduction

Fungal diseases are a major problem occurred in fruit and vegetable cultivations and during post-harvest life of fruits and vegetables. Application of systemic fungicides is the most common practice for commercial control of most of the post-harvest pathogens. Although synthetic fungicides have provided effective control of major postharvest diseases, their application may be harmful to human health and the environment and they become ineffective after prolonged use (Awoit*et al*, 2013).There are some natural plant products with antifungal activity against various fungal groups. Those natural compounds can be used to control the post-harvest fruit and vegetable pathogens in environmental friendly manner(Paster*et al*., 1995).

## Methodology

The current study was conducted to determine the antifungal activity of the leaves of *Azadirachtaindica*(Neem) and *Calendula officinalis*Linn(Marigold) and the peel of the fruit of *Myristicafragrans*(Nutmeg) against post-harvest disease causing fungal species such as*Colletrotrichumgloeosporioides*, *Fusariumoxysporum*,*Rhizoctonia solani* and *Trichoderma*spp. This experiment was conducted at the laboratories of Natural Products Chemistry division of the Institute of Fundamental Studies (IFS), Kandy.

The selected plant materialswere collected from the home gardens in Kandy. Plant materials were cleaned well under running tap water and air dried. The dried plant materials were crushed. Each plant powder (50 g) was extracted with hexane,ethyl acetate, methanol and distilled water respectively in a sequential process and the evaporation of solvent using rotary evaporator finished 12 extracts.The fungal cultures were obtained from Pathology Division of Horticultural Crops Research and Development Institute (HORDI), Gannoruwa, which were isolated from fruits and vegetables. The antifungal assay was conducted in 9cm diameter petri dishes. The extracts were dissolved in 10% Dimethyl sulfoxide (DMSO) to prepare 5000 ppm concentration of each extractand the 10% DMSO without plant extracts was used as the negative control.

The poisoned food technique (Chutia*et al*., 2009) was used to test for the antifungal activity. Plant extracts were mixed with the Potato Dextrose Agar (PDA) medium and poured to the petri dishes. The test fungal groups were inoculated with 8 mm diameter mycelial disc from 7- 10 daysold cultures. The plates were incubated at room temperature and colony diameter was measured after three days. This experiment was conducted by using Two Factor Factorial in Complete Randomized Design and data analysis was done by using Analysis of Variance (ANOVA) in General Linear Model. The mean comparison was done by using Tucky pairwise

comparison method at significance level of 5% ($\alpha = 0.05$) in Minitab 17 software.

**Results and Discussion**

Average colony diameter of each fungal species relevant to each plant extract is given in the table 1.

Table 1: Effect of the plant extracts on the growth of each fungal species

(H- Hexane,EA- Ethyl acetate,M- Methanol, DW- Distilled water, NC- Negative control)

| Plant | Solvent | Colony diameter (mm) | | | |
|---|---|---|---|---|---|
| | | *R. solani* | *C. gloeosporioides* | *F. oxysporum* | *Trichoderma*spp |
| *A. indica* | H | $42.00^{bc}$ | $15.67^{bc}$ | $17.33^{ab}$ | $47.67^{bc}$ |
| | EA | $35.00^{bcd}$ | $18.00^{bc}$ | $17.33^{ab}$ | $46.33^{bcde}$ |
| | M | $40.33^{bc}$ | $16.67^{bc}$ | $11.67^{b}$ | $40.00^{de}$ |
| | DW | $40.00^{bc}$ | $16.33^{bc}$ | $15.33^{ab}$ | $39.67^{ef}$ |
| *C. officinalis* | H | $39.33^{bc}$ | $23.67^{abc}$ | $19.67^{ab}$ | $46.33^{bcde}$ |
| | EA | $41.33^{bc}$ | $21.33^{abc}$ | $17.33^{ab}$ | $48.00^{bc}$ |
| | M | $42.00^{bc}$ | $23.33^{abc}$ | $19.67^{ab}$ | $49.33^{abc}$ |
| | DW | $36.67^{bcd}$ | $22.67^{abc}$ | $22.33^{ab}$ | $51.67^{ab}$ |
| *M. fragrans* | H | $29.33^{cd}$ | $13.33^{bc}$ | $14.00^{b}$ | $43.00^{cde}$ |
| | EA | $31.00^{bcd}$ | $12.33^{c}$ | $14.33^{ab}$ | $32.33^{f}$ |
| | M | $26.00^{d}$ | $13.00^{bc}$ | $14.67^{ab}$ | $39.00^{ef}$ |
| | DW | $43.00^{b}$ | $26.33^{ab}$ | $23.67^{ab}$ | $47.33^{bcd}$ |
| | NC | $57.33^{a}$ | $31.67^{a}$ | $26.33^{a}$ | $56.67^{a}$ |

* Values followed by the same letter are not significantly difference at $p \leq 0.05$ when subjected to Tukey pairwise comparison.

According to the results of this experiment, the lowest growth diameter against *R. solani* was given by the methanol extract of the fruit peel of *M. fragrans* (26 mm). The growth of the *C. gloesporioides* was highly controlled from ethyl acetate extract of the fruit peel of *M. fragrans*(12.33 mm). The lowest growth diameter against *F. oxysporum*was given by the methanol extract of the *A. indica* leaves(14 mm) and the growth of the *Trichoderma*spp was highly controlled from ethyl acetate extract of the fruit peel of *M. fragrans* (32.33 mm). With these results the *M. fragrans* shows higher antifungal activity for *C. gloesporioides*, *R.solani* and *Trichoderma*spp than other extracts while*A. indica* shows higher antifungal activity against *F. oxysporum*.

## Conclusions

The best antifungal extract against *R. solani* is methanol extract of fruit peel of*M. fragrans* and the best antifungal extract against *C. gloeosporioides* and *Trichoderma*spp is ethyl acetate extract of fruit peel of *M. fragrans* plant. The best antifungal extract against *F. oxysporum* is methanol extract of *A. indica* plant.

## References

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# Technical efficiency of Mirahawatte organic tea smallholders: a stochastic frontier approach

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## Introduction

Organic agriculture is now becoming very famous among Sri Lankan farmers as it is able to catch more foreign exchange to the country. World public is more concerning on sustainable agro-product consumption to secure the economic, environmental and social benefits. Tea is one of the most prominent organic export crops in Sri Lanka. The relevant actions need to take to develop the organic tea production in the country. Before moving to that, most effective solution to upgrade the production is increasing the technical efficiency; ability to produce maximum output using existence inputs and technology. Measuring the technical efficiency will prove the actual sustainability of tea industry in economics terms.

Sri Lanka tea industry consists with estate sector and tea smallholdings. Contribution from the tea smallholders to the national tea production was 72% in 2013 (Ministry of Plantation Industries, 2013).As tea smallholders play a major role in Sri Lankan economy, analyzing technical efficiency is imperative. Main objectives targeted to measure the value of technical efficiency of tea smallholders in Mirahawatte and to find out the determinants of technical efficiency of organic tea smallholders in Mirahawatte.

## Methodology

Technical efficiency of Mirahawatte organic tea smallholders were measuredin this study with 71 organic tea small holders registered under Marginalized Organic Producer's Association. Stochastic frontier model was used to estimate the technical efficiency. Primary and secondary panel data were collected during the period of 2011/2012 to 2013/2014. Technical efficiency was estimated by a stochastic frontier function using a Cobb-Douglas model, incorporating technical inefficiency effect model. In Cobb-Douglas model effect of eight inputs against output was measured. In technical inefficiency function, sixteen variables were identified as efficiency components oftechnical inefficiency. Data ware analyzed using STATA version 11 and frontier 4.1c computer programme.

$Y_{it} = exp(x_{it}\beta + V_{it} - U_{it})$; (Battese andCoelli, 1995)

Cobb-Douglas model specification is,

$$ln(Y_{it}) = \beta_0 + \beta_1 ln(x_1)_{it} + \beta_2 ln(x_2)_{it} + \beta_3 ln(x_3)_{it} + \beta_4 ln(x_4)_{it} + \beta_5 ln(x_5)_{it} + \beta_6 ln(x_6)_{it} + \beta_7 ln(x_7)_{it} + \beta_8 ln(x_8)_{it} + V_{it} - U_{it}$$

Specification of technical efficiency function is,

$$U_{it} = \delta_0 + \delta_1(Z_1)_{it} + \delta_2(Z_2)_{it} + \delta_3(Z_3)_{it} + \delta_4(Z_4)_{it} + \delta_5(Z_5)_{it} + \delta_6(Z_6)_{it} + \delta_7(Z_7)_{it} + \delta_8(Z_8)_{it} + \delta_9(Z_9)_{it} + \delta_{10}(Z_{10})_{it} + \delta_{11}(Z_{11})_{it} + \delta_{12}(Z_{12})_{it} + \delta_{13}(Z_{13})_{it} + \delta_{14}(Z_{14})_{it} + \delta_{15}(Z_{15})_{it} + \delta_{16}(Z_{16})_{it} + W_{it}$$

Table 1: Description of variables of Cobb-Douglas model

| Notation | Variable | Description |
|---|---|---|
| $Y$ | Output | Kilograms |
| $\beta_0$ | Parameter for intercept of regression line | |
| $x_1$ | Land extent | Acre |
| $x_2$ | Family labour | Mandays |
| $x_3$ | Hired labour | Rupees |
| $x_4$ | Compost utilization | Kilograms |
| $x_5$ | Liquid fertilizer utilization | Litres |
| $x_6$ | Plant protection utilization | Grams |
| $x_7$ | Dolomite utilization | Kilograms |
| $x_8$ | Poultry manure utilization | Kilograms |
| $V$ | Random error | |
| $U$ | Efficiency component of technical inefficiency | |

Table 2 : Description of the variables of the technical inefficiency model

| Notation | Variable | Description |
|---|---|---|
| $Z_1$ | Age of farmer | Years |
| $Z_2$ | Gender | Dummy (1=male,0=female) |
| $Z_3$ | Occupation dummy 1 | Dummy (1=none, 0=otherwise) |
| $Z_4$ | Occupation dummy 2 | Dummy (1=informal, 0=otherwise) |
| $Z_5$ | Occupation dummy 3 | Dummy (1=formal, 0=otherwise) |
| $Z_6$ | Experience in tea cultivation | Years |
| $Z_7$ | Experience in organic farming | Years |
| $Z_8$ | Education | Scored (1=below O/L, 2=O/L, 3=A/L,4=Degree) |
| $Z_9$ | Other income | Rupees per month |
| $Z_{10}$ | Age of plantation | Years |
| $Z_{11}$ | Pruning frequency | Years |
| $Z_{12}$ | Pruning practice | Dummy (1=yes, 0=no) |
| $Z_{13}$ | Training | Times |
| $Z_{14}$ | Post | Dummy (1=yes, 0=no) |
| $Z_{15}$ | Crop dummy 1 | Dummy (1=VP, 0=otherwise) |
| $Z_{16}$ | Crop dummy 2 | Dummy (1=seedling, 0=otherwise) |
| $W$ | Unobservable random variable | |

**Results and Discussion**

According to the maximum likelihood estimates for the prameters of stochastic frontier, land extent became significant at 1% significant level and family labour and hired labour became significant at 10% significant level. All the variables had a positive relationship with the output. Gamma (γ) value is 0.626. Accordingly, 62.6% of random variation on organic tea production is explained by inefficiency.

Maximum likelihood estimates of parameters for the inefficiency model are mentioned in Table 4. Age, gender, occupation dummy 1, occupation dummy 3, experience in tea cultivation, experience in organic farming, education and crop dummy 2 become significant. According to those results, technical efficiency would be increased by increasing younger, male, experienced and VP tea cultivated smallholders. Unemployed and the smallholders engaged in formal occupations obtained more efficiency.The mean technical efficiency was found to be 71.39%. Technical efficiency ranged between 10.12% and 94.45%.

Table 3: OLS and Maximum Likelihood Estimates for the parameters of stochastic frontier

| Variable | Parameter | Coefficient | | SE | | t ratio | |
|---|---|---|---|---|---|---|---|
| | | OLS | MLE | OLS | MLE | OLS | MLE |
| Constant | $\beta_0$ | 5.758*** | 7.219*** | 0.309 | 0.432 | 18.587 | 16.68 |
| Land extent | $\beta_1$ | 0.862*** | 1.168*** | 0.111 | 0.102 | 7.712 | 11.348 |
| Family labour | $\beta_2$ | 0.093** | 0.069* | 0.041 | 0.038 | 2.281 | 1.809 |
| Hired labour | $\beta_3$ | 0.077*** | 0.04* | 0.019 | 0.02 | 3.87 | 1.917 |
| Compost | $\beta_4$ | 0.024 | 0.006 | 0.019 | 0.018 | 1.209 | 0.367 |
| Liquid fertilizer | $\beta_5$ | 0.065** | -0.008 | 0.03 | 0.035 | 2.12 | -0.246 |
| Plant protection | $\beta_6$ | 0.048 | 0.045 | 0.041 | 0.042 | 1.093 | 1.111 |
| Dolomite | $\beta_7$ | -0.022 | -0.0001 | 0.029 | 0.03 | -0.765 | -0.004 |
| Poultry manure | $\beta_8$ | -0.0009 | 0.0008 | 0.022 | 0.021 | -0.043 | 0.042 |
| $\sigma^2$ | 0.387 | | | | | | |
| $\gamma$ | 0.626 | | | | | | |
| Log likelihood | | -0.00011 | -0.007 | | | | |
| LR test | | 0.663 | | | | | |

**: Significance at 10%, **: Significance at 5%, ***: Significance at 1%*

Table 4: Determinants of inefficiency of Cobb-Douglas model for organic tea small holders

| Variable | Parameter | Coefficient | Standard error | t ratio |
|---|---|---|---|---|
| Age | $\delta_1$ | 0.07*** | 0.015 | 4.451 |
| Gender | $\delta_2$ | -1.652*** | 0.49 | -3.31 |
| Occupation dummy 1 | $\delta_3$ | -1.328** | 0.65 | 2.042 |
| Occupation dummy 2 | $\delta_4$ | -0.57 | 0.578 | -0.986 |
| Occupation dummy 3 | $\delta_5$ | -1.705* | 0.978 | -1.743 |
| Experience in tea | $\delta_6$ | -0.042** | 0.02 | -2.099 |
| Experience in organic | $\delta_7$ | -0.39*** | 0.118 | -3.304 |
| Education | $\delta_8$ | 1.202*** | 0.257 | 4.667 |
| Other income | $\delta_9$ | -0.00001 | 0.00001 | -0.955 |
| Age of plantation | $\delta_{10}$ | -0.005 | 0.03 | 0.179 |
| Pruning frequency | $\delta_{11}$ | -0.007 | 0.063 | -0.12 |
| Pruning practice | $\delta_{12}$ | 0.081 | 0.351 | 0.231 |
| Training | $\delta_{13}$ | -0.176 | 0.162 | -1.086 |
| Post | $\delta_{14}$ | -0.594 | 0.546 | -1.088 |
| Crop dummy 1 | $\delta_{15}$ | -0.365 | 0.522 | -0.7 |
| Crop dummy 2 | $\delta_{16}$ | 1.746** | 0.738 | 2.365 |

**: Significance at 10%, **:Significance at 5%, ***:Significance at 1%*

## Conclusion

There is still 28.61% of remaining potential to develop the output levels without increasing input levels and technology. Several policy recommendations can be given. Empowering policies to attract especially young people and females, organizing special extension programmes for elder smallholders, arranging regular meetings among farmer groups to share knowledge from experienced farmers and government involvement to increase replanting subsidy are the identified recommendations.

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# Assessment of oil yield and quality in cinnamon (*Cinnamomum zeylanicum* Blume) leaves under different severity levels of two types of leaf galls

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## Introduction

Leaf gall infestation in cinnamon, is one of the prominent pest damage found in cinnamon cultivations. In cinnamon, two conspicuous leaf gall types are available. They are upper leaf galls caused by jumping plant louse (Trioza cinnamomi), a homopteran and lower leaf galls caused by Eriophyes boisi, a mite belongs to family Eriophyidae. Two pests are plant sappers and form galls on leaf blade as their habitats. The feeding by Eriophyes boisi or Trioza cinnamomi causes abnormal cell development and formation of galls. Each gall type is identical and their dimensions are variable. The galls are solitary and widespread on the leaf blade but are not on the veins. These Gall forming pests generally do little damage to plants and its bark yield because the affected parts are able to carry out photosynthesis with near normal efficiency. But cinnamon leaf oil yield and its quality may be changed significantly due to gall forming (Perera et. al., 1985; Prematilaka and Dharmadasa, 1995). Therefore this study was conducted to determine the effect of two different leaf galls in cinnamon leaves under different severity levels on the leaf oil content and quality of oil.

## Methodology

Cinnamon leaf samples infested with two types of galls, were collected from a field in Palolpitiya, Matara. Leaves only suffered from upper and lower gall infestations were harvested separately and categorized each of them into five pre-determined severity levels for oil extraction. Four severity levels of upper leaf gall infestation 1-50, 51 – 100, 101 – 150 and more than 151 galls per leaf and four severity levels of lower leaf gall infestation 1-15, 16 – 30, 31 – 45 and more than 46 galls per leaf were compared with cinnamon leaves without galls separately. Five treatments were assigned in randomized complete block design with five replicates. 50 g of air dried cinnamon leaf sample taken from each severity level was weighed and all the galls in the sample were isolated and weighed. Weight of galls in each severity level was expressed as a percentage to the whole sample weight. Each sample was subjected to extract leaf oil by hydro distillation. Amount of the major chemical components present in the extracted oil samples were measured by performing Gas Liquid Chromatography (GLC). Oil content and quality were subjected to analysis of variance and regression analysis by SAS programme.

## Results and Discussion

Thus it revealed that leaf oil contents were significantly different with the intensity of upper gall infestation (Table 1). It was observed that cinnamon leaf oil content had been lost from 10.48% at 25.62% severity to 74.26% at 97.26% severity. Same trend was observed in the case of lower

gall infestation (Table 2), but oil reduction due to this infestation had been occurred from 25.87% at 22.7% severity to 96.45% at 99.63% severity. Experimental results showed that mite galls (lower leaf galls) had reduced the oil yield in greater than the insect galls (upper leaf galls). Both upper and lower leaf gall infestations were caused to reduce the oil yield in cinnamon leaves and those infestations showed a strong negative significant relationship with the oil content in cinnamon leaves (Fig. 1 and 2). Prematilaka and Dharmadasa (1996) reported about 35% of oil reduction could be made due to upper leaf gall infestation, but the current study revealed that loss of oil content has been varied on severity of infestation.

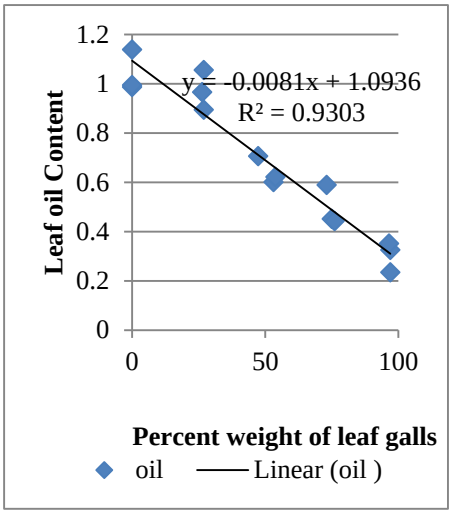


Figure 1: Correlation between leaf oil content under different infestation levels of upper leaf galls (proportion weight of leaf galls)

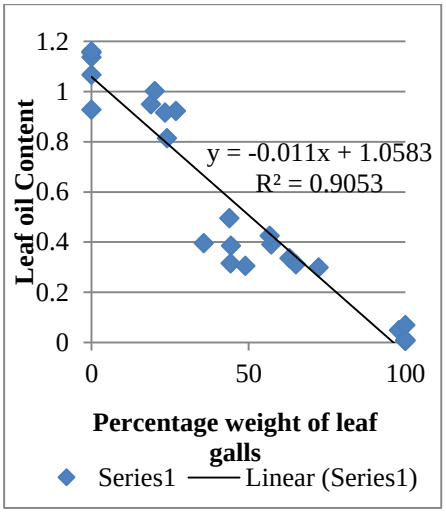


Figure 2: Correlation between leaf oil content under different infestation levels of lower leaf galls (proportion weight of leaf galls)

Table 1: Changes of cinnamon oil contents and its major components under different severity levels of upper leaf galls infestation made by *Trioza cinnamomi*

| Severity level (No. of galls) | Percent Weight of galls | Oil content (%) | Eugenol | Acetyl Eugenol | Cinnamaldehyde |
|---|---|---|---|---|---|
| 1(no) | 00.00 $^{e}$ | 1.05 $^{a}$ | 85.44 $^{cb}$ | 5.47 $^{c}$ | 1.88 $^{c}$ |
| 2 (< 50) | 25.62 $^{d}$ | 0.94 $^{b}$ | 86.80 $^{ab}$ | 4.91 $^{c}$ | 2.09 $^{bc}$ |
| 3 (51 – 100) | 51.43 $^{c}$ | 0.68 $^{c}$ | 84.29 $^{c}$ | 7.61 $^{a}$ | 2.04 $^{bc}$ |
| 4 (101 – 150) | 74.41 $^{b}$ | 0.49 $^{d}$ | 87.23 $^{a}$ | 7.75 $^{a}$ | 2.72 $^{ab}$ |
| 5 (> 151) | 97.26 $^{a}$ | 0.27 $^{e}$ | 82.34 $^{d}$ | 6.31 $^{b}$ | 3.48 $^{a}$ |
| P value | 0.0001 | 0.0001 | 0.0007 | 0.0001 | 0.006 |
| CV | 3.038 | 10.103 | 1.14 | 7.11 | 17.69 |
| LSD (α=0.05) | 1.99 | 0.09 | 1.77 | 0.83 | 0.79 |

Mean values in each column followed by the same letters are not significantly different (p>0.05)

While there was a significant reduction of eugenol content in cinnamon leaf oil, upper leaf gall infestation significantly increased an acetyl eugenol and cinnamaldehyde contents which are minor components in cinnamon leaf oil (Table 1). Significant reduction of eugenol content and

increment of cinnamadehyde content were observed when intensity of lower leaf gall infestation was increased (Table 2).

Table 2: Changes of cinnamon oil contents and its major components under different severity levels of upper leaf galls infestation made by *Eriophyes boisi*

| Severity level (No of galls) | Percent weight of galls | Oil content (%) | Eugenol | Acetyl eugenol | Cinnamaldehyde |
|---|---|---|---|---|---|
| 1(no) | 00.00$^{e}$ | 1.09$^{a}$ | 87.4867$^{a}$ | 3.627 $^{c}$ | 1.068$^{b}$ |
| 2(<15) | 22.70$^{d}$ | 0.92$^{b}$ | 83.2140$^{b}$ | 9.482 $^{ab}$ | 1.950$^{ab}$ |
| 3(16-30) | 43.49$^{c}$ | 0.38$^{c}$ | 78.7500$^{c}$ | 12.230 $^{a}$ | 2.495$^{ab}$ |
| 4(31-45) | 62.93$^{b}$ | 0.25$^{d}$ | 76.3150$^{d}$ | 8.436 $^{b}$ | 4.717$^{a}$ |
| 5(46<) | 99.60$^{a}$ | 0.03$^{e}$ | 73.5320$^{e}$ | 6.770$^{bc}$ | 4.640$^{a}$ |
| P value | 0.0001 | 0.0001 | 0.0001 | 0.0087 | 0.0775 |
| CV | 9.114 | 13.160 | 0.94 | 22.492 | 53.59093 |
| LSD($\alpha$=0.05) | 5.59 | 0.09 | 1.411 | 3.434 | 2.3244 |

Mean values in each column followed by the same letters are not significantly different (p>0.05)

This is clear evidence that leaf gall infestation may change the chemical physiology of leaf oil in addition to leaf oil content. It may be happened due to disturbance or blocking shikimic acid pathway in some extent at a point before producing eugenol in the leaf, so it is yet to be investigated detail in future.

## Conclusions

Both leaf gall infestations have an ability to change the leaf oil content and quality significantly in cinnamon and there was a strong negative significant relationship with intensity of infestation and cinnamon leaf oil content. In term of oil quality, there was a negative correlation between intensity of gall infestation and eugenol content, but positive correlation with cinnamaldehyde contents and acetyl eugenol as well.

## Acknowledgement

Laboratory facilities provided by the National Cinnamon Research and Training Center, Matara are acknowledged.

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# Development of low Glycemic Index bread using a composite flour mixture

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## Introduction

Composite flour technology is initially referred to process of mixing wheat flour with cereal and legume flour for making bread and biscuits. However, the term can also be used with regard to mixing of non-wheat flours, roots and tubers or other raw materials (Singh and Raguvanshi, 2011).Bread is a product obtained by baking yeast leavened dough prepared from wheat flour and with or without the addition of ingredients and permitted additives (SLS 141: 1992). The Glycemic Index (GI) of a food refers to the effect the food has on the body's blood sugar levels. Modern day people seek to avoid wheat flour bread, due to health risk. There is growing interest about nutrients content in bread using composite flour technology. Therefore, this research was carried out to develop low Glycemic Index bread as a solution for various health effects occurred due to the consumption of wheat bread.

## Methodology

The current study was carried out at Food Research Unit, Gannoruwa. Six experimental trials with different treatments were conducted during this study. Finally three treatments were prepared and evaluated on sensory and microbial analysis. 10%, 12% and 14% finger millet incorporated, treatments were used for sensory evaluation. The sensory evaluation was done using 15 semi trained panelists. In chemical analysis, proximate composition was determined for moisture content, fat, crude protein, ash, fiber, total carbohydrate and calcium. Specific volume was measured in selected three bread dough and bread samples using Modified Rapeseed Displacement Method. Texture was measured using a penetrometer for selected bread sample from sensory evaluation. Microbiological analysis was done for Escherichia coli, Total Plate Count (TPC), yeast and mould. Self-life determination was done by stored normal temperature with polythene wrap and without polythene wrap. Glycemic Index was measured using ten healthy volunteers in Food Research unit

## Result and Discussion

According to the sensory evaluation, the 12% finger millet incorporated bread was selected as best bread sample by giving good texture, taste, aroma and colour.

According to the figure 01, just after baked mean pressure become 0.83 kg. Then texture was soft. The pressure gradually increased with the time. With the time texture become harder than just after baked. After two hours mean pressure was 16.67 kg. Texture is mainly governed by gluten percentage. High gluten content gives soft texture due to gluten network. In this bread,

Finger millet flour was used. Due to it fibrous content it affects for the texture and it gives more hard texture with the time. High pressure show poor texture.

Figure 01: Mean Pressure Change with the Time

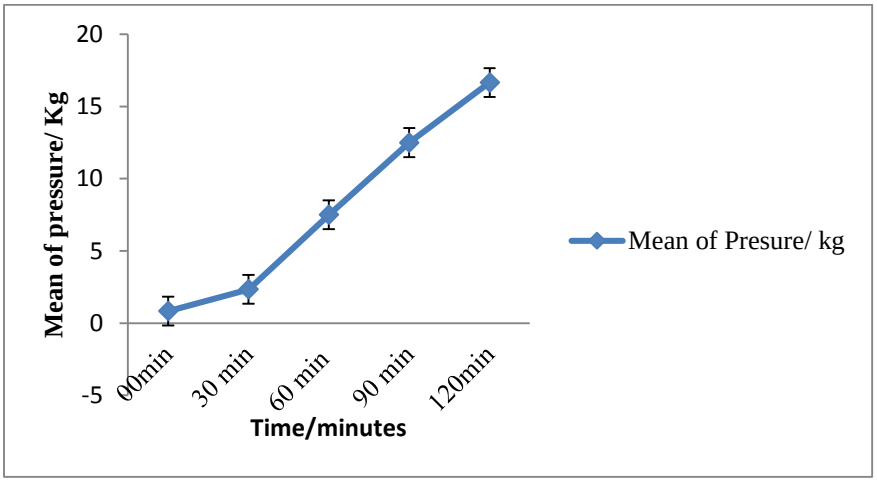


Table 01: Specific Volume of Bread Dough

| Finger millet % | Specific volume Time/ $kg^{-1}m^3$ | | |
|---|---|---|---|
| | 00 min | 30min | 60min |
| 14% | 670±104.4 | 790±61.10 | 1430±137.4 |
| 12% | 810±55.07 | 900±61.3 | 1600±290.91 |
| 10% | 820±41.6 | 1100±110.5 | 1950±60 |

Mean ± SD determination in triplicate

According to the Table 02 and table 03, specific volumes of bread dough and bread sample were decreasing when increasing finger millet flour percentage. Initially the highest specific volume obtained by 10 % finger millet flour incorporated bread dough and bread. Lowest specific volume obtained from 14% Finger Millet incorporated bread dough and bread.When increasing Finger Millet flour percentage, the percentage of wheat flour was decreased. Due to that ability of stretch of the dough was restricted. Reason is decrease of gluten and week gluten structure.

Table 03: Specific Volume of Bread

| Finger millet % | Specific volume Time/ $kg^{-1}m^3$ |
|---|---|
| 14% | 2150± 51.96 |
| 12% | 2280± 172.14 |
| 10% | 2530± 326.54 |

Mean ± SD determination in triplicate

According to the table 04, Due to soy flour selected bread was containing high protein than wheat bread. Therefore this bread is suitable for vegetarian as a protein supplement. When considering fat content and total carbohydrate content lower than wheat bread. High fiber

content good for the diabetic patients because it helps for low digestibility. This bread contain high amount of calcium. Thus this bread formula gives good supplement of calcium. Finger millet flour content is the main reason for this high calcium percentage.

Table 04: Proximate Analysis

| Proximate Composition | Selected bread sample | Wheat bread* |
|---|---|---|
| Moisture % | 31.2 | 40 |
| Ash% | 3.5 | 0.1 |
| Crude Protein% | 20.3 | 10.49 |
| Ether Extract ( Fat)% | 8.6 | 11.8 |
| Crude Fiber % | 2.9 | 0.25 |
| Calcium g/kg | 2.7 | 0.13 |
| Total Carbohydrate% | 33.5 | 73.5 |

*****Source: SLS 141: 1992 and Tiimub, 2013

TPC in the samples and presence of yeast and mould in samples complied with the requirement of Sri Lankan Standard (SLS). Zero *E.coli*shows the safe of consumer.There was no detectable moulds growth on breads, Wrapped using 150 gage polythene, during the first 48 hours from baking. There was detectable microbial growth under normal room temperature after 48 hours of baking.GI for the prepared bread sample was 57. Then this bread is included in Moderate Glycemic Index food. Moderate Glycemic Index foods are good for the diabetic patients. Therefore, prepared bread is good for diabetic patients.

**Conclusions**

Prepared bread has best nutritional profile and it is safe and helps to protect healthiness of consumers with good sensory properties. This bread can be used as balance diet for children and adults.According to the Glycemic Index value prepared bread is good for healthy consumers as well as diabetic patients.

**Acknowledgement**

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Tiimub, B.M., 2013Proximate analyses of three brands of bread under different storage conditions available on the Ghanaian market.*Food Science and Quality Management***[**Online] Available at http://www.iiste.org.

# Development of a protocol for *in-vitro* propagation of black pepper (*Piper nigrum* L.) local selections

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## Introduction

Black pepper (Piper nigrum L.) belongs to family Piperaceae and it is one of the most economically important spice crops in the world (Srinivasan, 2007; Mathew et al., 2001). Unavailability of sufficient mother plant stock in the field, obtaining basal runners for propagation and less success and multiplication rate of the high yielding local pepper cultivars are the major problems faced by the farmers who cultivate. Being in vitro propagation a promising option, this study was focused to develop a suitable protocol for in vitro propagation of black pepper local selections.

## Methodology

This research was carried out at Central Research Station, Department of Export Agriculture, Matale. Four experiments were conducted during the research period. Experiment one was conducted to find out the suitable surface sterilization method for the sterilization of black pepper shoot tips. Selecting of appropriate media for the culture establishment of black pepper shoot tips were carried out in second experiment using 1/3Murashige and Skoog (MS) medium and 1/2 Woody Plant Medium (WPM).Experiment three was conducted to find out suitable combination of auxin and cytokinin for the shoot multiplication of black pepper local selections. In fourth experiment, priority was given for the selection of best media and hormonal combination for the callus initiation of TG7 black pepper local selection. Full and half strength MS media were used as the culture media and two different concentration levels of kinetin and NAA were used as the growth regulators. Complete Randomized Design (CRD) was used as the experimental design. ANOVA was used to analyze the statistical difference of parametric data and non-parametric data were subjected for logarithmic transformation. SAS statistical software was used to analyze the data and mean separation was performed using Least Significant Difference (LSD).

## Results and Discussion

As the results summarized in Table 1, sterilization using 10%- 20% Clorox for five to ten minutes (T1 to T5) showed higher percentages of bacterial contamination (40 to 80 %). Lower percentages of fungal contamination was observed in T4 to T8 within the period of three to five days (3% to 7%).The highest survival percentage (66.6 %) was reported in T8, 0.04 % HgCl2 for five minutes. Similarly, the lowest percentages of bacterial and fungal contamination were observed in T8. The highest percentage of phenolic browning (80%) was shown in T6 and lowest percentage of phenolic browning (10.0%) was observed in T2, i.e. 10% Clorox for 10 minutes within four to seven days.

Table 2 : Percentages of survival, bacterial and fungal contamination and phenolic browning at different surface sterilization methods

| Treatment | Survival % | Bacterial % | Fungal % | Browning % |
|---|---|---|---|---|
| T1- 10% Clorox for 5 minutes | 15.0 | 50.0 | 20.0 | 15.0 |
| T2- 10% Clorox for 10 minutes | 0 | 80.0 | 10.0 | 10.0 |
| T3- 15% Clorox for 5 minutes | 15.0 | 40.0 | 15.0 | 30.0 |
| T4- 15% Clorox for 10 minutes | 35.0 | 40.0 | 5.0 | 30.0 |
| T5- 20% Clorox for 5 minutes | 10.0 | 50.0 | 5.0 | 35.0 |
| T6- 20% Clorox for 10 minutes | 15.0 | 0 | 5.0 | 80.0 |
| T7- 0.1% $HgCl_2$ for 1 minute | 38.5 | 26.9 | 7.6 | 26.9 |
| T8- 0.04% $HgCl_2$ for 5 minutes | 66.6 | 18.18 | 3.01 | 12.12 |

In experiment two, there was a significant difference between two media (1/3 Murashige and Skoogmedium and 1/2 Woody Plant Medium) for the shoot development of black pepper local selections. As shown in table 2, 1/2 Woody Plant Medium showed the highest mean survival (0.4892) three weeks after culturing.

Table 3: Mean survival rate of Black Pepper shoot tips in 1/3Murashige and Skoog (MS) medium and 1/2 Woody Plant Medium (WPM)

| Medium | Mean of Survival |
|---|---|
| 1/3 MS | 0.16250[b] |
| 1/2 WPM | 0.48920[a] |
| LSD | 0.0782 |

Means with same letters along the columns are not significantly different at probability level of 0.05

Table 4: Mean number of shoots, number of leaves and shoot length of shoot tip cultures affected by various growth hormones

| Treatment | | | Mean shoot number | Mean leaves number | Mean shoot length |
|---|---|---|---|---|---|
| BA(mg/L) | NAA(mg/L) | Kinetin(mg/L) | | | |
| T1-3.0 | 0 | 0 | 2.0 [a] | 4.4 [a] | 0.1 [c] |
| T2-3.0 | 0.5 | 0.1 | 1.4 [c] | 4.5 [a] | 0.1 [c] |
| T3-3.0 | 0.5 | 0.2 | 1.5 [bc] | 3.9 [a] | 0.1 [c] |
| T4-3.0 | 1.0 | 0.1 | 2.3 [a] | 4.6 [a] | 0.3 [b] |
| T5-3.0 | 1.0 | 0.2 | 1.9 [ab] | 4.4 [a] | 0.4 [a] |
| | LSD | | 0.434 | 0.8446 | 0.125 |

Means with same letters are not significantly different at probability level of 0.05

According to the Table 3, higher number of shoots were observed in T4, followed by T1and T5.Higest number of leaves were observed in T4.There was a significant difference in shoot length between treatments. The highest shoot length was observed in T5. With considering number of shoots and shoot length, Woody Plant Medium with 3 mg/L BA, 1.0 mg/L NAA and 0.2 mg/L Kinetin was the best hormonal combination for shoot multiplication of black pepper local selections(T5).

As the table 4 shows, there was no significant difference between two media (Full strength MS and half strength MS) for the callus formation.

Table 5. The status of callus formation on full and half strength MS media

| Media | Mean Callus formation |
|---|---|
| Full strength MS medium | 0.54 [a] |
| Half strength MS medium | 0.49 [a] |
| LSD | 0.07 |
| CV% | 18.7 |

Means with same letters are not significantly different at probability level of 0.05

As Table 5 indicates, there was a significant difference between the T2, T4 and T5 for the callus formation. The highest callus development (0.74 score) was observed in T4.

Table 6.Callus development in different kinetin and NAA level fourweeks after culture

| Treatment No | Treatment | | Mean score | Color |
|---|---|---|---|---|
| | NAA (mg/L) | Kinetin (mg/L) | | |
| T1 | 0.5 | 1.0 | 0.69 [ab] | Whitish brown |
| T2 | 0.5 | 1.5 | 0.55 [c] | Whitish brown |
| T3 | 1.0 | 1.0 | 0.59[bc] | White |
| T4 | 1.0 | 1.5 | 0.74 [a] | White |
| T5 | 0 | 0 | 0.0 [d] | No |
| LSD | | | 0.11 | |
| CV% | | | 18.71 | |

Within the column means with same letters are not significant at probability level of 0.05

**Conclusions**

In development of a protocol for *in vitro* propagation of black pepper (*Piper nigrum* L.) local selections, following methods for surface sterilization, culture establishment, shoot multiplication and callus induction are established.The best surface sterilization method for the shoot tips of black pepper local selections is 0.04 % Mercuric Chloride for five minutes. Half of WPM supplemented with 3.0 mg/L of BA and 1.0 mg/L of kinetin is the best media for the culture establishment using shoot tips of black pepper local selections. The best hormonal combination for the shoot multiplication of black pepper local selections is WPM with 3.0 mg/L of BA, 1.0 mg/Lof NAA and 0.2 mg/L of Kinetin. Either full or half strength MS medium supplemented with 1mg/L of NAA and 1.5 mg/L of Kinetin is better to use for callus induction from leaves of black pepper local selections.

**Acknowledgement**

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Srinivasan, K. (2007). Black pepper and its pungent principle-piperine: A review of diverse physiological effects Critical Rev. Food Nut. 47: 735-748.

# Analysis of technical efficiency of pepper growers in Kandy district

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## Introduction

Pepper is the second most important perennial spice crop, next to Cinnamon, in Sri Lankan economy, and the most important perennial spice for domestic consumption. The pepper growers have faced severe problems during the last decades. Some of these problems are prolonged fall in the production and productivity of pepper. Agricultural productivity refers to the output produced by a given level of input(s) in the agricultural sector of a given economy (Fulginiti and Perrin 1998). Technical efficiency reflects the ability of producers to maximize output for a given set of resource inputs (Chirwa 2003).The Department of Export Agriculture in Sri Lanka with the mandate of perennial spices launched several programmes to develop this sector, including subsidy schemes for new planting, replanting and infilling, fertilizer subsidy schemes and extension services. Despite such efforts, the performances of spice based agro-forestry systems are not **satisfactory**. The average yield of pepper is 350-500 kg per hectare, but target yield is 1000 kg per hectare (Department of Export Agriculture in Sri Lanka 2002). Farmers have less information on efficiency. In order to realize increased production and efficiency, farmers in Sri Lanka need to efficiently utilize the limited resources accessed for farm income generation. This research determined efficiency levels of pepper farmers and identified socio economic factors affecting efficiency levels.

## Methodology

The study was conducted in Kandy District in 2014. Kandy district comprises with 6,982.8 ha of cultivated land of pepper. The total sample size was hundred (100) respondents from six selected extension office ranges. Multi Stage sampling technique was used. Primary sample data was collected from farmers using a survey method involving a structured questionnaire which was administered to the selected pepper producing farmers in Kandy District. The analysis of Cobb-Douglas frontier production function was tested by ordinary least square (OLS) and maximum likelihood estimation (MLE). STATA version 11 was used for the summary statistics and estimate coefficient of stochastic frontier and measure technical efficiencies.

## General model and variables

In the model specification,

$$Y_{it} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + v_i - u_i$$

Table 1: Production Function Variables

| Variable | Parameter | Remarks |
|---|---|---|
| Yield of pepper | $Y_{it}$ | Kilograms ( kg) |
| Land extent | $x_1$ | Acre |
| Family labour | $x_2$ | Man days |
| Hired labour cost | $x_3$ | Rupees (Rs:) |
| Fertilier utilization | $x_4$ | Kilo grams (kg) |
| Dolomite utilization | $x_5$ | Kilo grams (kg) |
| Number of pruning | $x_6$ | Number |
| Weedicide cost | $x_7$ | Rupees (Rs:) |
| Number of manual weeding | $x_8$ | Number |

Technical Inefficiency Function

In the model specification,

$$U_I = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} + \varepsilon_i$$

Table 2: Technical Inefficiency Function Variables

| Variable | Parameter | Remarks |
|---|---|---|
| Age of farmer | $Z_1$ | Years |
| Gender | $Z_2$ | If Male= 1,Otherwise = 0 |
| Field visits by Extension officer | $Z_3$ | Number |
| Subsidy received | $Z_4$ | If Received= 1, Otherwise=0 |
| Experience in pepper cultivation | $Z_5$ | Years |
| Plantation Age | $Z_6$ | Years |
| Education | $Z_7$ | Primary = 1 Below O/L =2 A/L= 3 Degree or Diploma= 4 |
| Number of trainings attended | $Z_8$ | Number |
| Occupation dummy 1( Informal) | $Z_9$ | If Informal occupation= 1 ,Otherwise =0 |
| Occupation dummy 2 (Formal) | $Z_{10}$ | If Formal occupation=1, Otherwise =0 |

**Results and Discussion**

Table 3: Ordinary Least Square and Maximum Likelihood Estimates for the parameters of stochastic frontier

| Variable | Co Efficient | | Standard Error | | P value | |
|---|---|---|---|---|---|---|
| | OLS | MLE | OLS | MLE | OLS | MLE |
| Land Extent | 0.8255534*** 0.7491909*** | | 0.1183377 | 0.104854 | 0.000 | 0.000 |
| Family Labour | -0.1266223** -0.1302913** | | 0.0546958 | 0.0528619 | 0.023 | 0.015 |
| Hired Labour Cost | 0.0671582* 0.0904791*** | | 0.0361036 | 0.0298858 | 0.066 | 0.002 |
| Dolomite application | 0.0819011*8 | 0.0429783 | 0.041237 | 0.0357624 | 0.050 | 0.229 |
| Fertilizer applicaation | 0.0370185 | 0.0313447 | 0.0407722 | 0.0348231 | 0.366 | 0.372 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Manual Weeding | -0.5796257** | | 0.2835348 | 0.2515604 | 0.044 | 0.026 |
| | -0.5664492** | | | | | |
| Pruning | -0.0071533 | 0.0667656 | 0.3607513 | 0.3085742 | 0.984 | 0.830 |
| Weedicide Cost | -0.1587041*** | | 0.0579177 | 0.0458077 | 0.007 | 0.000 |
| | -0.1759709*** | | | | | |
| Constant | 5.425643 | 5.741027 | 0.4920459 | | 0.000 | 0.000 |
| $\gamma$ | 0.740005 | | | | | |
| $\sigma^2$ | 1.493149 | | | | | |

** Significant at 10 % ** Significant at 5 % and *** Significant at 1 %*

Estimates were done by using both OLS and MLE. According to the frontier output, land extent, family labour and hired labour were significant. As extent of Pepper land was increased by one percent, yield of Pepper was also increased by 0.82 percent on average when other variables remained constant.

The coefficient of hired labour cost was significant and had a positive sign for pepper farmers, indicating that pepper production is labor intensive, especially at weeding and harvesting stages. This implies that optimal use of labor will lead to increased output. Adebayo (2006) and Ogundele and Okoruwa (2006) inferred that hired labor contributed positively to farm productivity.

Table 4: Technical Efficiency Ranges of the Farmers

| Technical Efficiency range | Farmer TE percentage of the sample |
|---|---|
| 0-10 | 1 |
| 10-20 | 2 |
| 20-30 | 2 |
| 30-40 | 5 |
| 40-50 | 7 |
| 50-60 | 10 |
| 60-70 | 7 |
| 70-80 | 15 |
| 80-90 | 21 |
| 90-100 | 30 |

Table 5: Statistics of Technical Efficiency

| Technical Efficiency | Mean | Std.Deviation | Minimum | Maximum |
|---|---|---|---|---|
| | 73.64 | 21.80 | 7.74 | 99.29 |

Table 6: Determinants of Technical Inefficiency

| Variable | Co efficient | Standard error | z | P>\|z\| |
|---|---|---|---|---|
| Age | 0.206257 ** | 0.0945559 | 2.18 | 0.029 |
| Gender | -0.8659193 | 0.9426061 | -0.92 | 0.358 |
| Field visit | -0.9265452 | 0.7164361 | -1.29 | 0.196 |
| Subsidy | 2.198565 | 1.905281 | 1.15 | 0.249 |
| Experience | -0.0546185 | 0.0448456 | -1.22 | 0.223 |
| Plantation age | -0.0269816 | 0.0508191 | -0.53 | 0.595 |
| Education | 0.1609216 | 0.6826663 | 0.24 | 0.814 |
| Training | -0.3276421 | 0.2541289 | -1.29 | 0.197 |
| dumy1 | 0.8216772 | 1.33086 | 0.62 | 0.537 |
| dumy2 | 0.7006096 | 1.68 | 0.42 | 0.677 |
| _cons | -11.54224 | 6.443964 | -1.79 | 0.073 |

** Significant at 10 % ** Significant at 5 % and *** Significant at 1 %*

Analysis of the inefficiency model contained in above Table 3 pepper production shows the signs and significance of the estimated parameter coefficients in the inefficiency model have important implications on the technical efficiency of pepper producers in the study area. Coefficients of age were positive for the pepper farmers. The coefficient of age was significant and gender was not significant for farmers. These coefficients imply that relatively older in age experience lower technical efficiency.

**Conclusion**

The research assessed technical efficiency of pepper production in Kandy District and determined the socio-economic factors affecting the pepper production. The research revealed mean value of the technical efficiency of the farmers in Kandy District was 73.64. The findings in this study showed that pepper farms were efficient where the mean of technical efficiency of pepper farms were high. The technical efficiency was ranged from 7.74 to 99.29 per cent. Majority of the farmers have technical efficiency between 90-100 per cent. There was a vast difference between technical efficiency levels of farmers even if they used the same level of inputs.

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# Feasibility study for direct planting of *in vitro* potato (*Solanum tuberosum* L.) varieties Granola and Golden Star in aeroponic system

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## Introduction

The major constraints in potato cultivation are high seed cost, poor seed quality, unavailability of quality seeds at correct time for planting, frequent application of fungicides to control late blight disease, misappropriation of agrochemicals and limitation of suitable land. The total seed potato requirement in Sri Lanka is about 22,500mt per annum. Total annual importation of seed potato is about 7000mt and the Department of Agriculture produces about 400mt of high generation seed potato per annum. The rest of the seed potato requirement of about 60% is fulfilled by farmers own seed production. Seed potatoes are the most costly input having 53% of the total cost of production.Main objective is to study the feasibility of direct planting of Granola and Golden star in vitro plants in aeroponic system. Other objective is to identify the suitable liquid media for hardening of in vitro potato plants.

## Materials and method

The planting materials which were used in research are In vitro potato plants, MS media, Albert solution and aeroponic system. First culture media was prepared for in vitro potato plants. Stock solution was measured to prepare MS medium. Then 0.1g of myo-inositol, 30g of sugar, 1g of charcoal and 9g of agar were measured and mixed well. Solution was diluted up to the 1l. pH was measured and adjusted up to 5.75. Culture bottles were filled by solution up to 30ml. Bottles were allowed for settle.*In vitro* plants were cut with node and cuttings were placed in culture bottles. Then bottles were labeled and placed in the culture room. Cultured bottles were kept for one month period.

Half MS, full MS and Albert solution were prepared. pH was measured in MS solutions and adjusted to 5.75. Electrical conductivity was adjusted up to 1.7 in Albert solution. Six treatments were taken. (Golden star in 1/2 MS medium as treatment 1, golden star in MS medium as treatment 2, golden star in Albert solution as treatment 3, granola in 1/2 MS medium as treatment 4, granola in MS medium as treatment 5, granola in Albert solution as treatment 6) Data were collected at one week intervals. Mean shoot length, mean root length and mean number of roots were taken as the parameters. (In this research increment of growth was measured for each parameters)

Albert solution was prepared for 250l of tank (EC-1.643 ms/cm). Electrical conductivity was adjusted up to the range of 1.5 to 2.0 ms/cm. Acclimatized plants were dipped in Thiram (2g/l). Then plants were placed in aeroponic system. Aeroponic system was adjusted to spray five second with once in five minutes at day time and once in fifteen minutes at night in first three

days. Next four days system was adjusted once in ten minutes at day time and once in twenty minutes at night. After that system was adjusted once in twenty minute at day time and once in thirty minutes at night. EC was checked every day. Data were collected at weekly for seven weeks. Mean shoot length, mean root length, mean stolen length, mean number of stolen and mean number of tubers were taken as the parameters. (In this research increment of growth was measured for each parameters)

**Results and Discussion**

In both experiments collected data were analyzed by using minitab 16 under general linear model. According to the Table 1, the highest shoot length growth (3.13cm) was observed in variety Golden star with Albert solution (T3). Others are statistically different, but T6, T1 and T3 are comparable. Though T2, T4 and T5 are comparable but significantly lower than T3. When comparing mean length of root growth, there is no significant different in each treatment. Number of root increment are statistically significant each other. Therefore using of any treatment is not largely effect on root number or root length.

Table 7 : Mean comparison of each responses in each treatment in 1st week in acclimatize period.

| Treatment | Mean Shoot length (cm) | Mean Root length (cm) | Mean Num. of Root |
|---|---|---|---|
| T1 | $2.50^{ab}$ | $0.23^{a}$ | $0.30^{a}$ |
| T2 | $1.45^{b}$ | $0.15^{a}$ | $0.00^{a}$ |
| T3 | $3.13^{a}$ | $0.18^{a}$ | $0.40^{a}$ |
| T4 | $1.26^{b}$ | $0.50^{a}$ | $0.00^{a}$ |
| T5 | $1.52^{b}$ | $0.17^{a}$ | $0.00^{a}$ |
| T6 | $2.05^{ab}$ | $0.32^{a}$ | $0.30^{a}$ |

* Means that do not share a letter are significantly different.

According to the Table 2, the highest shoot length growth (6.58 cm) was observed variety Golden star with Albert medium (T3). Second higher value observed in T1, T2 and T6. When comparing mean of the root growth, the highest root growth increment (0.49cm) having variety Golden star with Albert medium (T3) and T6 (Granola*Albert) also having the second highest root length. According to the analyze root number increment are not statistically significant. Therefore use of any treatment has not largely effected on root number.

Table 8 : Mean comparison of each responses in each treatment in 2nd week in acclimatize period

| Treatment | Mean Shoot length (cm) | Mean Root length (cm) | Mean Num. of Root |
|---|---|---|---|
| T1 | $3.09^{b}$ | $0.23^{bc}$ | $0.60^{a}$ |
| T2 | $2.22^{b}$ | $0.26^{abc}$ | $0.00^{a}$ |
| T3 | $6.58^{a}$ | $0.49^{a}$ | $0.80^{a}$ |
| T4 | $0.67^{c}$ | $0.13^{c}$ | $0.00^{a}$ |
| T5 | $0.87^{c}$ | $0.08^{c}$ | $0.10^{a}$ |
| T6 | $3.17^{b}$ | $0.37^{ab}$ | $0.70^{a}$ |

* Means that do not share a letter are significantly different.

According to the Table 3 the highest values of mean length of shoot growth were recorded in T1, T2 and T3. When considering mean length of root growth T1 and T2 recorded the highest values and T3 was recorded the second highest value. According to the mean length of stolen growth, there is no significant difference between T1, T2 and T3. When considering mean number of stolen growth, there is no significant difference between T1 and T2. According to the treatment combination T1, T2 and T3 were having highest number of stolen growth. Therefore Golden star performed well as a variety in terms of mean length of shoot growth, mean length of root growth, mean length of stolen growth and mean number of stolen growth. When considering the mean number of tubers growth T4, T5 and T6 were performed well.

Table 9: Mean of stolen number, stolen length and number of tuber according to initial treatments in aeroponic system

| Treatment | Mean shoot length (cm) | Mean root length (cm) | Mean stolen length (cm) | Mean number of stolen | Mean number of tubers |
|---|---|---|---|---|---|
| T1 | $40.11^{a}$ | $67.21^{a}$ | $33.23^{a}$ | $10.80^{a}$ | $0.00^{b}$ |
| T2 | $35.40^{a}$ | $65.91^{a}$ | $33.43^{a}$ | $11.00^{a}$ | $0.00^{b}$ |
| T3 | $35.91^{a}$ | $51.25^{b}$ | $36.06^{a}$ | $8.90^{ab}$ | $0.00^{b}$ |
| T4 | $8.13^{b}$ | $34.11^{c}$ | $23.09^{b}$ | $3.40^{c}$ | $15.50^{a}$ |
| T5 | $6.95^{b}$ | $36.67^{c}$ | $23.36^{b}$ | $3.00^{c}$ | $15.50^{a}$ |
| T6 | $8.25^{b}$ | $26.97^{c}$ | $24.18^{b}$ | $6.00^{bc}$ | $14.10^{a}$ |

* Means that do not share a letter are significantly different.

**Conclusion**

Albert solution is the best medium which gives the best result with each varieties. Though there is a similarity with the medium one (1/2 MS medium) and the Albert solution it can be avoided with the comparison to the cost. When considering the experiment two though there is a higher vegetative growth with the variety Golden star, variety Granola is performed well with in lower time period. In this research, Tuber initiation of the plants should be in low time period to fulfill the research problem (Increase the production of seed potato production).

Another thing is to reduce the cost for the production of seed potato. Normally seed potato production method get more than six month of period. In this research it is reduced up to below one month of period. Because of that cost for the crop management can be reduced.Moreover that using in vitro plant give the identical seed potato to have next generation with the best yield via quality and quantity.

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# Labour migration and paddy production; a comparative analysis

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## Introduction

Migration can be identified as the flow or movement of people from the place of origin to the other surrounding, whether inside or outside the country with various reasons. Migration plays a major role in the economic development of Sri Lanka. In recent years, the outflow of Sri Lankan workers has shown an increasing trend. Sri Lanka is predominantly an agricultural country and paddy sector receives the highest priority in development agenda in Sri Lanka, as rice is the staple food in the country. At present Sri Lankan paddy sector suffers from many constraints such as scarcity of arable land, high cost of inputs and scarcity of labour (Ranathunga, 2011). Scarcity of labour for paddy production occurs mainly due to labour migration (Paris.et.al, 2009). In many studies, researchers find out the various impacts of migration. But it is very fewer Sri Lankan studies on examine the impact of labour migration on paddy production. In this context the objectives of the study were (i) to find out the impact of labour migration on paddy production and (ii) to estimate the production function of paddy in relation to the labour migration.

## Methodology

Research was carried out Galaha, Thalathuoya and MarassanaGovijanaseva divisions under the Pathahewahata Divisional Secretariat division in Kandy District. Multi stage sampling technique was used to select 150 paddy farm families from selected area. Multi stage sample was surveyed based on a semi structured pre-tested questionnaire to gather necessary information. Both descriptive and inferential statistics were used to analysis the data. Descriptive statistical methods were used to describe the characteristics of the sample such as demographic information about paddy farmers and migrants, production details in paddy and labour usage in paddy cultivation. Cobb-Douglas Production function was used for econometrics analysis.(Nonthakot and Villano, 2008).

Empirical model : $\ln Y = \beta 0 + \beta i \ln (X i) + \varepsilon i$

The Y is the yearly output from paddy production in kilograms. Xi denotes the vector of independent variables such as family labour input, land extend, yearly fixed capital, fertilizer inputs, seed quantity, land quality and household type. In paddy production labour is used under three categories, family labour, hired labour and exchange labour. Among those categories family labour was used for the empirical model. Labour input was measured in man days. Variable of land extend was measured by acre. Yearly fixed capital gives the real value of all machinery, equipment, and value of land in rupees. Variable of fertilizer input shows the amount of fertilizer usage per year in kilograms. Variable of the seed quantity shows the quantity of seed paddy used for cultivation in kilograms. Land quality is a dummy variable distinguishing whether it is irrigated land or not. Household type is a dummy variable indicating the household with at least one out migrant. The references group is the household without any out migrant.$\varepsilon i$ is the stochastic disturbance term.

## Results and Discussion

According to descriptive statistics, nearly 78% in the sample was male and the rest 22% were female. Most of farmers in the sample were older than 40 years. 58% farmers of the sample were

educated up to ordinary level. Most of farmers in this area had a higher level of experience. 39% of farmers had more than 30 year experience. 40% of farmers had10 to 30 years experience. Farmers in this area had a diversified income sourcing, income from paddy cultivation, vegetable and other crops cultivation, animal husbandry, from private sector and government sector occupation and specially from the remittances. Most of farmers get 100000 to 600000 rupees income per year. In that income category 58.06% were migrant household and 41.94% were non-migrant household.

Most of farmers in the area engage in small scale paddy cultivation. Most of them (48%) cultivate less than an acre. Only 1.32% farmers cultivate more than 3 acre. The area gets 1500kg/acre average productivity. To cultivate 1 acre of land area need 70 man days, on average. 55% from the total sample were migrant household and 45% were non-migrant household. Among the migrants 74% were male and 26% were female. Most of migrants were very young people (<30 years). There were 121 migrants in the sample. Among them 81% were send in remittances to their household.In econometric analysis, first present the findings on the determinants of paddy production of the total sample.Labour input played a positive role in paddy production with elasticity being around 6.77 for households.Fertilizer was significant with a positive relationship. 1% increase of fertilizer caused to increase yield by 0.37%.Quantity of seed paddy was significant with-1.62 elasticity. Land quality is significant with -0.02elasticity.

Table 1: Results of the OLS Estimation in Household of the Total Sample

| Variable | OLS |
|---|---|
| Intercept | -5.34*** |
| Labour | 6.77*** |
| Land | 0.03 |
| Capital | -0.002 |
| Fertilizer | 0.37*** |
| Seed Quantity | -1.62*** |
| Land quality | -0.02* |
| Household Type | -0.005 |
| $R^2$ (%) | 99.81 |
| N | 150 |

*, **, *** Significant at 10, 5 and 1 percent probability level, respectively
Source - Sample survey, 2014

In second, present the major findings on the determinants of paddy production of the two type of households: Non migrant household (column 1) and migrant household (column 2) in Table 2. The impact of labour input on paddy yield varied across two type of households, with 1% of labour input yielding 6.72 % increase in paddy output in non-migrant household and 6.9 % yield increase in migrant household. Fertilizers also had positive relationship with both households. The elasticity of fertilizer was 0.29 in non-migrant household and 0.42 in migrant household.

Seed quantity was significant in both household but with a negative relationship. 1% increment of seed quantity caused to 1.31% of yield reduction in non-migrant household and 1.84% of yield reduction in migrant household. There were three seed sowing methods in this area, broadcasting, transplanting and parachute method. Among those methods, for broadcasting need higher amount of seed paddy (approximately 41.74kg/acre) but yield is comparatively lower. For seed sowing in parachute method, need comparatively very low amount of seed paddy (approximately 2.6 kg/acre) but gives higher yield than other two method. Transplanting is in between these two methods. This is the reason behind negative relationship with seed quantity and paddy yield.

Land was significant only for non-migrant household with elasticity of0.04 and non significant towards the migrant household. Most of farmers in this area were not the owners of the paddy lands and they rent lands from the owners and pay for the lands with yield. Farmers in migrant family, not going to rent land from others. They only cultivate if they had their own lands. Because of that land is not significant towards the migrant house hold. Capital was negatively significant with the migrant household and no any effect towards the non-migrant household. In migrant household though it had many more capital like machinery and equipment no one to operate it (if the earlier operator migrate from paddy cultivation), availability of the capital was a cost. Because of that reason 1% increase of capital in migrant household caused to 0.05% reduction of yield.

Land quality does not significantly affect to the paddy production of migrant or non-migrant household. Because, in this area, non-irrigated lands are rich with spring water and other lands are fulfilled their water requirement by using irrigated water. So there is no significant issue towards the paddy yield.

Table 2: Results of the OLS estimation in two type of household

| Variable | Non-migrant Household | Migrant Household |
|---|---|---|
| Intercept | -5.40*** | -5.36 *** |
| Labour | 6.72*** | 6.84 *** |
| Land | 0.04* | 0.007 |
| Capital | 0.002 | -0.005 ** |
| Fertilizer | 0.29*** | 0.42 *** |
| Seed quantity | -1.31*** | -1.84*** |
| Land quality | -0.02 | -0.01 |
| $R^2$ (%) | 99.83 | 99.81 |
| N | 68 | 82 |

*, **, *** Significant at 10, 5 and 1 percent probability level , Source - Sample survey, 2014

**Conclusions**

According to the study, There is a significant different between labour input in migrant household and non-migrant household. Corresponding yield of a unit of labour input in migrant household is higher than the non-migrant household or household in a total sample. Corresponding yield of a unit input of fertilizer also higher in migrant household than non-migrant household. Seed quantity is significant in both household and in total sample with negative relationship. Land variable shows the positive relationship only with the non-migrant household. Capital is significant only towards the migrant household with negative relationship.The land quality was not significant in both type of households.

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# Effect of nitrogen fertilization on nitrate accumulation in radish (*Raphunus sativus*) and beetroot (*Beta vulgaris*)

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## Introduction

Nitrate is one of the most frequent utilized forms of N from soil and it is the major form of nitrogen taken up by plants. Through root they reach stem and leaf where in photosynthetic processes they convert into proteins. Due to exposure to stress situations and excessive nitrogen fertilization, nitrate accumulation in plant tissues and organs occurs (Krnjaja, 2008). Excess amount of nitrate caused health hazards. Vegetables are the major source of daily intake of nitrate by human beings, supplying about 72 to 94% of the total intake. The Acceptable Daily Intake (ADI) of nitrate ion has been given 3.65 mg $kg^{-1}$ body weight (Santamaria, 2006). Higher concentration of nitrate is badly affected to environment, animals, and humans. Main objectives of this research are to investigate the effect of nitrogen fertilization on nitrate accumulation in radish and beetroot and to determine plant part where the maximum nitrate accumulations take place.

## Methodology

The current study was carried out at Horticultural Crop Research and Development Institute, Gannoruwa. Five different N levels of DOA (Department of Agriculture) recommended dosages together full recommended TSP and MOP levels were applied as treatments. No fertilizer treatment used as a control. Field trail was arranged according to Randomized Complete Block Design with three replicates. Recommended spacing used for each crop.

Table 01. Treatments

| Treatment | Fertilizer Levels |
|---|---|
| T 1 | No fertilizer |
| T 2 | 0% of urea (N) + Full recommend MOP and TSP |
| T 3 | 50% of urea (N) + Full recommend MOP and TSP |
| T 4 | 100% of urea (N) + Full recommend MOP and TSP |
| T 5 | 150% of urea (N) + Full recommend MOP and TSP |
| T 6 | 200% of urea (N) + Full recommend MOP and TSP |

Radish samples were taken two times. Beetroot samples were taken at the time of harvesting stage. Samples were thoroughly washed and there after samples were oven dried at 60 $^0$C until constant weight is reached. Dried samples were ground. By using dried samples plant nitrate accumulation levels were measured dry weight basis and fresh weight basis.Used distillation method. Data was analyzed using analysis of variance (ANOVA) using the General Linear

Model (GLM) procedure of MINITAB 17. Significant means of treatments were separated using Tukey test ($P< 0.05$).

**Result and Discussion**

Four weeks after planting nitrate accumulation level in radish fresh weight (FW) basis is given in Table 02.

Table 02. Nitrate Accumulation Level in Radish in Root Parts and Leaf Parts

| | Mean $NO_3^-$ mg/kg FW basis | |
|---|---|---|
| Treatment | Root | Leaf |
| $T_1$ ( No Fertilizer ) | $25.69^{d}$ | $233.7^{d}$ |
| $T_2$ ( 0% Urea) | $79.85^{c\,d}$ | $113.2^{e}$ |
| $T_3$ ( 50% Urea) | $135.97^{c\,d}$ | $211.1^{de}$ |
| $T_4$ (100% Urea) | $175.40^{c}$ | $419.6^{c}$ |
| $T_5$ (150% Urea) | $435.30^{b}$ | $1173.5^{a}$ |
| $T_6$ ( 200% Urea) | $589.80^{a}$ | $1005.2^{b}$ |

Values followed by the same letters are not significantly different at $p\leq0.05$

Harvesting stage nitrate accumulation level in radish fresh weight (FW) basis is given in Table 03.

Table 03. Nitrate Accumulation Level in Radish in Root parts and Leaf Parts.

| | Mean $NO_3^-$ mg/kg FW basis | |
|---|---|---|
| Treatment | Root | Leaf |
| $T_1$ ( No Fertilizer ) | $170.2^{bc}$ | $260.1^{bc}$ |
| $T_2$ ( 0% Urea) | $106.0^{c}$ | $150.8^{c}$ |
| $T_3$ ( 50% Urea) | $187.5^{bc}$ | $205.1^{bc}$ |
| $T_4$ (100% Urea) | $277.47^{b}$ | $485.4^{b}$ |
| $T_5$ (150% Urea) | $463.3^{a}$ | $1410.4^{a}$ |
| $T_6$ ( 200% Urea) | $454.1^{a}$ | $1236.0^{a}$ |

Values followed by the same letters are not significantly different at $p\leq0.05$

When increasing nitrogen fertilization significantly ($p<0.05$) increased nitrate accumulation in root part and leaf part. Higher amount of nitrate accumulation was recorded in leaf part than root part in radish and beetroot. This finding is also supported by PietroSantamaria (2006) who stated that nitrate content differs in the various parts of a plant. Indeed, the vegetable organs can be listed by decreasing nitrate content as follows, petiole > leaf > stem > root > inflorescence > tuber > bulb > fruit > seed.

Harvesting stage nitrate accumulation level in beetroot fresh weight basis is given in Table 04

Table 04. Nitrate Accumulation Level in Beetroot in Root Parts and Leaf Parts

| | Mean $NO_3^-$ mg/kg FW basis | |
|---|---|---|
| Treatment | Root | Leaf |
| $T_1$ ( No Fertilizer ) | 160.3 [a] | 387.0 [a] |
| $T_2$ ( 0% Urea) | 311.7 [a] | 389.0 [a] |
| $T_3$ ( 50% Urea) | 315.3 [a] | 490.0 [a] |
| $T_4$ (100% Urea) | 261.1 [a] | 496.0 [a] |
| $T_5$ (150% Urea) | 341.0 [a] | 462.6 [a] |
| $T_6$ ( 200% Urea) | 266.0 [a] | 439.0 [a] |

Values followed by the same letters are not significantly different at $p \leq 0.05$

There was no significant difference in nitrate accumulation in root part among the treatments ($p > 0.05$). Leaf nitrate accumulation was no significant difference with other treatments but it was comparatively higher than the root part nitrate accumulation in beetroot. Similar results reported by Maynard & Barker (1972).Which showed that petioles and stems were generally the sites of maximum nitrate accumulation in beetroot (Vityakon, 2012).

**Conclusions**

Higher rate of nitrate accumulation was occurred in leaf parts than the root parts in radish and beetroot. Higher rates of nitrogen fertilizer levels were caused to higher level of nitrate accumulation in radish and beetroot. But through the application of recommended level of fertilizer doses can obtain optimum yield with minimum nitrate accumulation.

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# Development of stirred type fruit yoghurt using wood apple (*Limonia acidissima*)

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## Introduction

Consumption of fruits and milk is important for human health as they are good sources of protein, vitamins and minerals (Alakali *et al*., 2008). Fruit yoghurts have been popular among milk products in the world. But, it is not very common in Sri Lankan market. In manufacturing fruit yoghurts, fruit is usually added to milk product in the form of fruit preparations or as fruit flavors. But, manufacturing fruit yoghurts, with natural fruit pulp or juice is very important to provide nutritional and natural balance diet. Yoghurt has nutritional benefits beyond those of milk. Lactose-intolerant individuals can sometimes tolerate yoghurt better than other dairy products, because the lactose in the milk is converted to glucose and galactose, and partially fermented to lactic acid, by the bacterial culture. When, underutilize fruits are concerned, wood apple is one of fruit which is cheap, highly nutritious, perishable and seasonally available fruit in Sri Lanka (Vidhyaasree, 2012). Therefore, this research was carried out to develop a stirred type wood apple yoghurt as a nutritional dessert as well as a balance diet.

## Materials and Methods

Current study was carried out at Food Research Unit, Department of Agriculture, in Gannoruwa, Peradeniya. Laboratory analysis was conducted at Uva Wellassa University, Food Research Unit, Veterinary Research Institute and chemical laboratory in SGS Lanka (Pvt.) Ltd. A series of preliminary trials conducted to find out the best product for further evaluations and development. First preliminary trial was carried out to preparation of main ingredients. Under that, plain yoghurt preparation, wood apple pulp preparation and sugar and fresh milk addition were undertaken. Second preliminary trial was carried out to adjust the pH value, brix value of the product and texture, mouth feel and taste of the product. The third preliminary trial was carried out to create four different recipes. Mainly four different wood apple pulp amounts (5, 7.5, 10 and 12.5%) were added to prepare four different recipes. Sensory evaluation was conducted for colour, taste, odour, mouth feel and overall acceptability using 50 semi-trained panelists. In physicochemical analysis, pH, titratable acidity, total soluble solids, total fat, solid non fat, proximate analysis, calcium and phosphorus contents and microbial analysis yeast, mould and *Escherichia coli* were evaluated for selected product samples with SLSI recommended levels. Shelf life analysis was conducted by analyzing some physicochemical, microbiological and sensory properties of selected product sample during the 1$^{st}$, 4$^{th}$, 7$^{th}$, 11$^{th}$, 15$^{th}$ and 20$^{th}$ days of storage. Finally, cost of final product was analyzed. Sensory data were analyzed using computer aided MINITAB 14 statistical analysis package Friedman non-parametric test and physicochemical and microbial tests were analyzed using one way ANOVA at 95% level of significant.

## Results and Discussion

Ten percent of wood apple pulp incorporated fruit yoghurt gave the highest estimated medians (taste – 4.25, colour – 3.875, aroma – 4.5, mouth feel – 4.25, overall acceptability – 4.625) and the highest sum of ranks for all sensory attributes. Therefore, 10% of wood apple pulp incorporated recipe ($R_1$) has given a desirable product. Web diagram for sensory evaluation data is shown in figure 1.

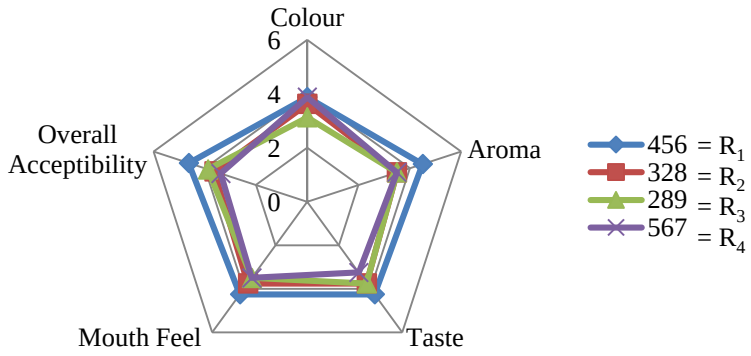


Figure 1. Web diagram for sensory evaluation data

According to physicochemical analysis (table 1), developed stirred type wood apple yoghurt product contained high protein (3.8%), calcium (166 ppm) and law fat (1%) content. Also, this newly developed product belonged to recommended level of SLSI, 1989 standard.

Table 1. Results of physicochemical analysis

| Food constituent | Plain yoghurt (SLSI) (per 100 g) | Fruit yoghurt (SLSI) (per 100 g) | Wood Apple yoghurt (per 100 g) |
|---|---|---|---|
| pH value | 4.2 – 6.5 | 4.2 -6.5 | 5.3 |
| Brix value | 20% | 20% - 35% | 28.4% |
| Titratable Acidity | 0.8 – 1.25 | 0.6 – 1.25 | 0.65% |
| Total Solids | > 20% | > 20% | 41.56% |
| Solid non fat | 8% | > 8% | 10.21% |
| Protein | 3.5% | 3.5% | 3.8% |
| Crude fat | 3% - 3.5% | 0.5% - 3% | 1% |
| Calcium | > 120 mg | > 120 mg | 166 mg |
| Phosphorus | - | - | 88.9 mg |

According to the shelf life study the product can be recommend as good quality food product for 15 days shelf life period. However, during this period product must be stored in 4$^{o}$C temperature in refrigerator condition. Web diagram for change of sensory data with storage time is shown in figure 2 and physicochemical data and microbial count for shelf life study is shown in table 2 and table 3.

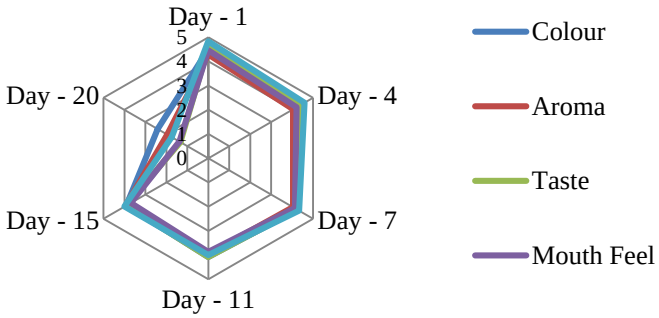


Figure 2. Web diagram for change of sensory data with storage time

Table 2. Physicochemical Data for Shelf Life Studies

| Storage (days) | Mean pH | Mean Brix % | Mean Titratable Acidity % |
|---|---|---|---|
| 01 | 5.32 ± | 28.4 ± | 0.65 ± |
| 04 | 5.32 ± | 28.4 ± | 0.65 ± |
| 07 | 5.29 ± | 28.4 ± | 0.65 ± |
| 11 | 5.28 ± | 28.0 ± | 0.66 ± |
| 15 | 5.26 ± | 28.0 ± | 0.66 ± |
| 20 | 4.76 ± | 28.0 ± | 0.69 ± |

According to the SLSI standards yeast count was not more than 1000 per 1 g, mould count was not more than one per 1 g and *E. coli* count must be negative in quality product.

Table 3. The Results of the Microbial Analysis for Shelf Life Studies

| Test Microorganisms | Day 1 | Day 4 | Day 7 | Day 11 | Day 15 | Day 20 |
|---|---|---|---|---|---|---|
| Mean Yeast (cfu) | 35 | 45 | 70 | 130 | 295 | 790 |
| Mean Mould (cfu) | 0 | 0 | 0 | 0 | 0 | 30 |
| Mean *E. coli* (cfu) | 0 | 0 | 0 | 0 | 0 | 0 |

Average commercial price for stirred flavoured yoghurt was Rs.45.00 in the August 2014. Allowing to the cost analysis, raw material cost for one wood apple yoghurt was Rs.19.77 is shown in table 4.

Table 4. Cost Analysis for Stirred Wood Apple Yoghurt Production

| Main Ingredients | Amount per 100 ml cup | Price per 100 ml cup |
|---|---|---|
| Plain Yoghurt | 84 g | Rs. 7.56 |
| Wood Apple Pulp | 13 g | Rs. 1.50 |
| Sugar | 11 g | Rs. 1.25 |
| Fresh Cow Milk | 16 ml | Rs. 0.96 |
| Other | Labour Cost, Electricity Cost, etc. | Rs. 8.50 |
| Total | | Rs. 19.77 |

## Conclusions

Ripe wood apple pulp can be introduced to yoghurt given the health benefits, higher sensory, physicochemical and microbiological properties. The selected best sample, 10% of ripe wood apple pulp gave acceptable results as SLSI standards. The product can be recommended as a quality food product for 15 days period under 4$^{o}$C temperature in refrigerator condition.

## Acknowledgment

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# Investigating the factors that influenced the excess use of pesticides by the vegetable farmers in Badulla and Nuwara-Eliya districts

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## Introduction

Pesticides are the results of modern technology and synthetic organic poisons used to exterminate specific organisms by inhibiting certain vital functions. They are applied predominately to kill or control weeds, insect pests and animals. Pesticides are widely used because of ease of application, high efficiency, temporary economic return and etc. (Nagenthirarajah and Thiruchelvam, 2008). When pesticides are help to farmers to get high production, massive usage of pesticides have been reported in many of commercial cultivations in whole around the world (Wilson and Tiddsell, 2001). Similar to many developing countries, pesticide related issues in Sri Lanka have become a major concern in the present day context. Majority of cases have been occurred due to the excessive usage of pesticides. Excess uses of pesticides have severe effects on environment and human health that may lead to an immediate and long term effects.

Therefore it is important to identify the factors effect on excess use of pesticides which can help to overcome the intensive use of pesticides over the years in vegetable cultivation. In this context, the objectives of the study were (i) To investigate the farmers' level of awareness in use of pesticides and (ii) To investigate the factors that cause to excess use of pesticides.

## Methodology

The research was carried out in up country vegetable growing areas of Badulla and Nuwara Eliya district. Bandarawela, Welimada and Nuwara-Eliya Divisional Secretariat divisions were selected as the study area. Stratified random sampling technique was used to select 600 vegetable farmers from Nuwara-Eliya, Walimada and Bandarawela Divisional Secretariat divisions. Information were collected from farmers based on a semi structured pre-tested questionnaire. Both descriptive statistical method and binary logistic regression technique were used to analyze the data. Minitab 15 Statistical Software was used to get the output of binary logistic analysis. The variables defined for the empirical model are shown in Table 1.

## Empirical model

$$Y = \beta_0 + \beta_1 LEX + \beta_2 CT + \beta_3 UHL + \beta_4 UFM + \beta_5 SI + \beta_6 THI + \beta_7 CP + \beta_8 AGE + \beta_9 EDUL + \beta_{10} EXP + \beta_{11} ND + \beta_{12} SF + \beta_{13} TF + \beta_{14} PLF + \beta_{15} MF + \beta_{16} FA + \varepsilon_i \ldots\ldots\ldots\ldots\ldots (1)$$

Where, $\beta_0$ to $\beta_{16}$ = coefficients; $\varepsilon_i$ = error terms

Table 1: Description of variables in the empirical model

| Notation | Variables | Remarks |
|---|---|---|
| Y | Farmers' probability of excess use of pesticides | If excess use = 1 Otherwise = 0 |
| LEX | Cultivated land extent | Acre |
| CT | Cropping type | If mono cropping = 1 Otherwise = 0 |
| UHL | Use of hired labour | If use hired labour =1Otherwise = 0 |
| UFM | Use of farm machinery | If use machineries = 1Otherwise = 0 |
| SI | Seasonal income | Rupees |
| THI | Total household income per season | Rupees |
| CP | Cost of pesticides | Rupees |
| AGE | Age of farmer | Years |
| EDUL | Farmers' education level | Years |
| EXP | Farmers' experience on vegetable cultivation | Years |
| ND | Number of dependents | Count |
| SF | Social factors | Five point likert scale |
| TF | Technical factors | Five point likert scale |
| PLF | Policy and legal factors | Five point likert scale |
| MF | Market factors | Five point likert scale |
| FA | Farmer awareness | Awareness scores |

Eight awareness statements were used to calculate attitude index in the above regression model. They are scaled according to the five point likert scale form "strongly agree" (5) to "strongly disagree" (1). The Attitude Index for each factory was then calculated using following equation, where the value 40 in the numerator shows the maximum value can be obtained if the respondent strongly agrees with 05 statements (i.e. 5 × 5).

$$Awareness\ index = \frac{Summation\ of\ 08\ statement\ of\ each\ farmer}{8} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

**Result and Discussion**

According to the descriptive statistics, it can be said that nearly 64% farmers over use pesticides and almost all the farmers depended on chemical pesticides for the management of pest and diseases. When consider the farmers level of awareness in use of pesticides, if farmers have less than good awareness then most of farmers tend to overuse of pesticides more than recommended rates. Similarly, when the farmers have very good awareness then most of farmers do not tend to over use of pesticides. Result shows that most of (38.4%) farmers have average knowledge on use of pesticides and 63.7% farmers tend to excess use of pesticides. Figure 1 shows the farmers level of awareness with pesticide usage.

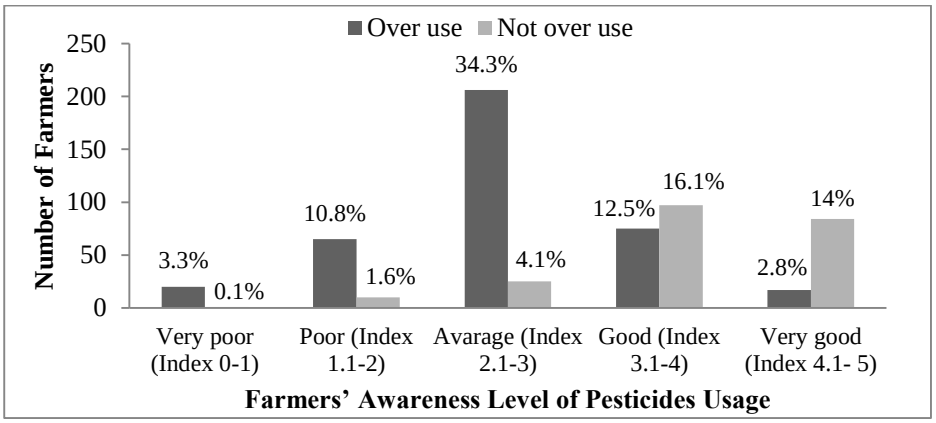


Figure 1: Farmers level of awareness with pesticide usage.

The Binary Logistic Regression model was used to determine the extent to which the identified factors affect farmers' probability of pesticide over usage and also quantify the relationship between dependent variable and independent variable. Binary Logistic Regression Model is yielded the following results.

Table 2: Results of the Binary Logistic Regression Analysis

| Variable | Coefficient | Standard Error Coefficient | Significant Value |
|---|---|---|---|
| Constant | 1.11215 | 2.58080 | 0.047** |
| LEX | 1.41592 | 0.507591 | 0.005*** |
| CT | 0.376077 | 0.364109 | 0.302 |
| UHL | -0.326939 | 0.432318 | 0.450 |
| UFM | -0.260718 | 0.710540 | 0.714 |
| SI | -0.0000011 | 0.0000033 | 0.736 |
| THI | 0.0000063 | 0.0000030 | 0.034** |
| CP | 0.0000069 | 0.0000135 | 0.612 |
| AGE | 0.0118588 | 0.0308302 | 0.700 |
| EDUL | -0.827147 | 0.293911 | 0.005*** |
| EXP | -0.0613994 | 0.0323089 | 0.057* |
| ND | -0.139205 | 0.127996 | 0.277 |
| SF | -2.11027 | 0.366147 | 0.0000*** |
| TF | 2.76283 | 0.477987 | 0.0000*** |
| PLF | -0.782096 | 0.181910 | 0.0000*** |
| MF | 1.22547 | 0.271988 | 0.0000*** |
| FA | -0.427377 | 0.0841074 | 0.0000*** |

Y = 1.11215 + 1.41592 LEX** + 0.376077 CT – 0.326939 UHL – 0.260718 UFM –0.0000011 SI – 0.0000063 THI* + 0.0000069 CP + 0.0118588 AGE – 0.827147EDUL** – 0.0613994 EXP** – 0.139205 ND – 2.11027 SF* + 2.76283 TF* – 0.782096 PLF* + 1.22547 MF* – 0.427377 FA*

*** Denotes significant at 0.01 level **Denotes significant at 0.05 level *Denotes significant at 0.1 level

R-Sq = 81.2%, Probability> F = 0.000

The model can be used to explain 81.2% of the variation of factors. Therefore this model is suitable to investigating the factors that influenced the excess use of pesticides.

## Conclusion

According to the study most of farmers have "average level" (awareness index= 2.1-3) of awareness in pesticide usage. As well results revealed that when the farmers' awareness was higher than "average level", there was less probability on excess use of pesticides and when farmers have "average level" or less than "average level" (awareness index < 3.1) awareness on pesticide usage, there was high probability on excess use of pesticides. Alsothe study indicate that Land extent, Total household income, Educational level, Farmers experience, Social factors, Technical factors, Policy and legal factors, market factors and farmers awareness are the factors which significantly affect to the excess use of pesticides.

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# Mapping soil chemical properties and leaf quality parameters relation to tobacco production in Sri Lanka: a GIS approach

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## Introduction

Tobacco (*Nicotianatabacum L*) holds an unparalleled position among crop plants and in overall terms, the status achieved by this single species is truly remarkable (Akehurst, 1981). This crop significantly influences on world trade as a leaf basis product and is also a commercially widely grown crop as a non–food field crop (Akehurst, 1981).The chemistry and fertility of soils greatly influence the tobacco plant growth, leaf size, yield and physical, chemical and manufacturing properties of tobacco leaf.Among factors that influence on tobacco productivity, soil fertility and fertilizer use contribute nearly 50% of the yield and quality improvement of tobacco crop (Krishnamurthy and Deosingh, 2002).

Thus, by changing the soil properties and water quality, the yield and the quality of the final product can be greatly changed. Identifying lands with suitable soil propertiesfor the cultivation will help to understand the correct fertilizer application. Fertilizer recommendation based on soil test is important for improving the fertilizer use efficiency and thereby to increase the yield and quality of tobacco.

An understanding of spatial distribution of soil properties in the field is important for refining agricultural management practices. Soil variability is the outcome of many processes acting and interacting across a continuum of spatial and temporal scales and inherently scale-dependent (Cambardella et al., 1994).

Therefore, the study of relationship between the soil chemical properties and leaf quality can provide a scientific basis to find potential lands for quality tobacco production.This research presents the future potential tobacco growing areas based on the tobacco leaf quality distribution.

## Materials and methodology

In this study,Galewala and Mahiyanganaya tobacco growing areas were chosen as sample area.Data were collected from primary and secondary sources. Soil property data which wererecorded Ceylon tobacco company's (CTC) lab reports were collected as secondary data. Global Positioning System (GPS) coordinates were taken fromthe field as primary data. Soil analysis was undertaken by collecting soil samples in studyareas from 15 cm deep from the soil surface. The soil samples were collected from ten different places of one land with approximately 1kg of weight. Soil samples were analyzed for pH, organic matter, electrical conductivity, soil texture, calcium, magnesium, potassium, sodium, calcium/magnesium ratio, magnesium/potassium ratio, phosphorous, acid saturation, cupper, ferrus, manganese and zinc. Leaf quality data were taken from the CTC lab reports and identified the leaf nicotine percentage, chloride percentage and sugar percentages from the plants in selected locations.

Major soil chemical properties which affectontobacco leaf quality were identified by correlation analysis in MINITABstatistics. Soil chemical property and tobacco leaf quality distribution maps were processed using interpolation technique in ArcGIS. Interpolated leaf quality maps were reclassified in four suitability rankings i.e. most suitable, suitable, moderately suitable and fairly suitable as shown in Table 01. Finally all leaf quality layers were integrated in a GIS environment to generate the potential map.

Table 01: Suitability factors for identifying potential areas tobacco cultivation

| Factor | Most Suitable | Suitable | Moderately Suitable | Fairly Suitable |
|---|---|---|---|---|
| **Leaf Nicotine%** | >3.5 | 3.0 – 3.5 | 2.5 – 3.0 | < 2.5 |
| **Leaf Sugar %** | < 10 | 10 – 14 | 14 – 18 | > 18 |
| **Leaf Chloride %** | < 0.6 | 0.6 – 0.8 | 0.8 – 1.0 | >1.0 |

**Results and Discussion**

According to correlation analysissoil pH and magnesium affected on nicotine, chloride and sugar levels in tobacco leaves. Low soil pH and low soil magnesium levels result in lower chloride level and sugar level in tobacco leaves.Acid saturation of the soil basically affected on the nicotine level of tobacco leaves. High acid saturation in soil result in high nicotine level in tobacco leaves. Soil potassium level affected on the chloride level of tobacco leaves. When potassium level of soil was lower chloride level of tobacco leaves was also lower. Sugar level of the tobacco leaves is affected by soil nitrogen level. Lower the nitrogen level in soil; lower the sugar level in tobacco leaves.

With lower soil pH levels, acidic cations; $Mn^{+2}$, $Fe^{+3}$ and $Al^{+3}$ are more available, however $Cd^{+2}$ like heavy metals are also available at lower pH values. Availability of these cations can be a reason for the reduction of chloride level and sugar level of tobacco leaves.Magnesium is a part of the chlorophyll in all green plants and essential for photosynthesis. It also helps to activate plant enzymes needed for growth. This may results for the difference of nicotine, chloride and sugar levels in tobacco leaves.Acid saturation is the percentage of the cation exchange capacity occupied by $H^{+}$ ions. Increasing the acid saturation will reduce the pH.Having too much of potassium in soil, it can lead to salt damage and acid fixation of the root system. It may result in increasing the leaf chloride level.Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy. According to the results, leaf sugar levels can be affected directly by soil nitrogen.

Therefore soil with low pH, low nitrogen, low magnesium, low potassium and high acid saturation are favorable for quality tobacco production as shown in Table 02.

Table 02: Relationship between composition of soil chemical properties and tobacco leaf quality

| Factors | Mean value | | |
|---|---|---|---|
| Leaf Nicotine % | pH | Mg (Kg/ha) | Acid Saturation% |
| 2 - 2.5 | 4.7 | 428.1 | 7.05 |
| 2.5 – 3 | 4.96 | 392.3 | 8.72 |
| 3 - 3.5 | 5.57 | 296.1 | 12.6 |
| 3.5 – 4 | 5.61 | 226.0 | 16.33 |
| Leaf Chloride % | pH | Mg (Kg/ha) | K (Kg/ha) |
| 0 - 0.625 | 4.95 | 290.4 | 219.9 |
| 0.625 - 1.25 | 5.31 | 344.8 | 237.1 |
| 1.25 - 1.875 | 5.862 | 470.3 | 345.2 |
| 1.875 - 2.5 | 6.35 | 573.5 | 332.5 |
| Leaf Sugar % | pH | Mg (Kg/ha) | N (Kg/ha) |
| 0 – 10 | 4.925 | 299.5 | 15.5 |
| 10 – 15 | 5.321 | 359.4 | 16.53 |
| 15 – 20 | 5.638 | 408.7 | 20.54 |
| 20 – 25 | 5.533 | 435.7 | 28.67 |

Mahiyanganaya area is the most suitable area for quality tobacco production. Mahiyanganaya; Rideela, Dehiaththakandiya, Sandunpura, NawaMadagama and Diyawiddagama were identified as most suitable areas for tobacco cultivation. Polonnaruwa; Siripura, Pallegama and Selasumgama were identified as the most suitable areas. Galewela; Tholombagolla and Kalawewa are the most suitable areas for quality tobacco production as shown in Figure 01.

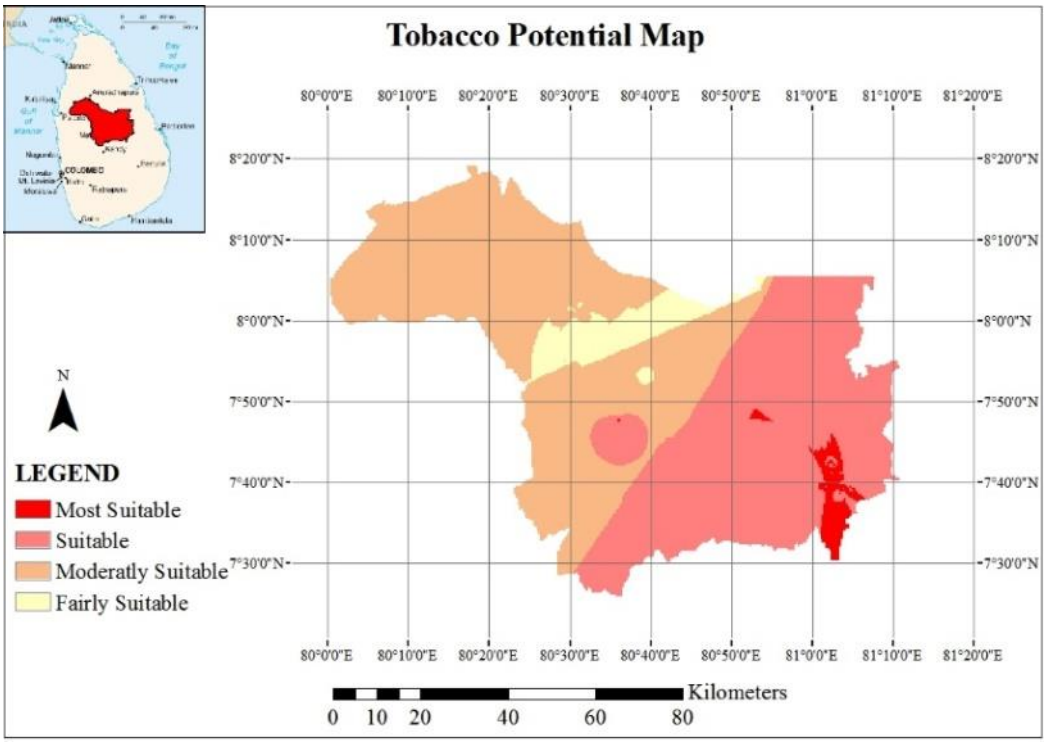


Figure 01: Tobacco Potential Map

## Conclusion

GIS based approach is a useful tool for assessing tobacco potential areas. Mahiyanganaya area is the most suitable area for quality tobacco production. Soil with low pH, low Nitrogen, low Magnesium, low Potassium and high Acid saturation are favorable for quality tobacco production.

Results of the study can be improved by adding evenly distributed sample locationsand analyzing with agro ecological conditions.

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# Willingness to adopt chemical leasing service by vegetable farming in Nuwara Eliya district, Sri Lanka

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## Introduction

Chemical leasing service is a new strategic business model which is service oriented to promote sustainable chemical management. This research paper aims to examine factors affecting on farmer willingness to adopt in chemical leasing service. Chemical Leasing definition developed by, United Nations Industrial Development Organization (UNIDO) "Chemical Leasing is a service-oriented business model that shifts the focus from increasing sales volume of chemicals towards a value-added approach. This represents an integrated preventive environmental strategy and a clear win-win situation for industry and the environment. The specific objectives of this study were to determine the vegetable farmers' willing to adopt on the chemical leasing model, to determine the vegetable farmers' willingness towards a chemical leasing service.

## Materials and methodology

Willingness to pay for agricultural services is influenced by a number of paradigms including the innovation-diffusion model (Francis M, el al 2010), economic constraints model (Makokha et. al, 1999).

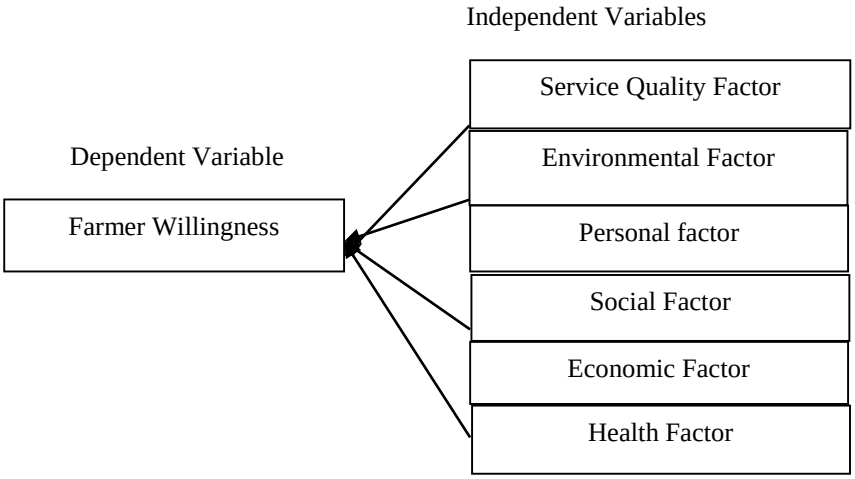


Figure 1: Conceptual Frame work

Figure 2.1 above shows the theoretical framework of the study. There are two variables discussed in this study as independent and dependent variable farmer willingness to adopt in chemical leasing showing dependency on Personal, social, economy, farmer health, environment, and Service quality.

The data applied in this study were collected in Nuwara Eliya by a questionnaire. The sample was determined by simple random sampling method. 150 farmers were selected as responders. Each head of household he/she was given a brief introduction about Chemical Leasing Service. The questionnaire used in the interviews was structured in one section contained straightforward questions. From second section to sixth section there are statement wise questions. Participants were asked to provide marks for the statements which are affected to their willingness to adopt Chemical Leasing service on decision.

Farmers were requested to record their responses on a five point likert scale as follows: Strongly disagree (1), disagree (2), not clear idea (3), agree (4) and strongly agree (5). The definitions of demographic/personal, social, environment, economic, health variables, and service quality variable and descriptive statistics of the sample are presented in descriptive statistics table. To achieve the objectives of this study; Chi-square test and Binary Logistic model were used. In the first analysis, chi-square contingency test was used to determine willingness to adopt chemical leasing service frequencies is independent of the respondents' demographic and other factors. The statistical program, Statistical package for Social Science (SPSS for Windows, version 22, SPSS) was used to transform where necessary, tabulate and analyse the data.

In binary logistic model the decision choice is a whether or not to have, adopt or not and this response is binary it takes on two values 0 and 1. $Y$= {0 *if* No, 1 *if* Yes}.

$$\text{logit}\,[p(x)] = \log\,[p(x)/1\text{-}p(x)] = a + b_1x_1 + b_2\,x_2 + b_3\,x_3 \ldots\ldots\ldots b_k\,x_k$$

$p$ = the probability that a case is in willingness to adopt,

a = the constant of the equation and,

b = the coefficient of the predictor variables.

$X_1$= Age

$X_2$= Area

$X_3$= outcome

$X_4$= Cost

$X_5$= pressure

$X_6$=Training

$X_7$=Store

$X_8$=Pay

$X_9$=Method

$X_{10}$=Safety

$X_{11}$= Other

$X_{12}$=Concern

$X_{13}$= Waste

**Results and Discussion**

A total of 150 observations, all with complete information on the variables included in the empirical model, were analysed. As valid percent only 80% of the respondents are willingness to adopt for chemical leasing service. The other respondents are 20% are not willingness to adopt for chemical leasing service. From frequencies of 150 respondents 120 responders willing to accept this new strategic model and other 30 responders are not willing.

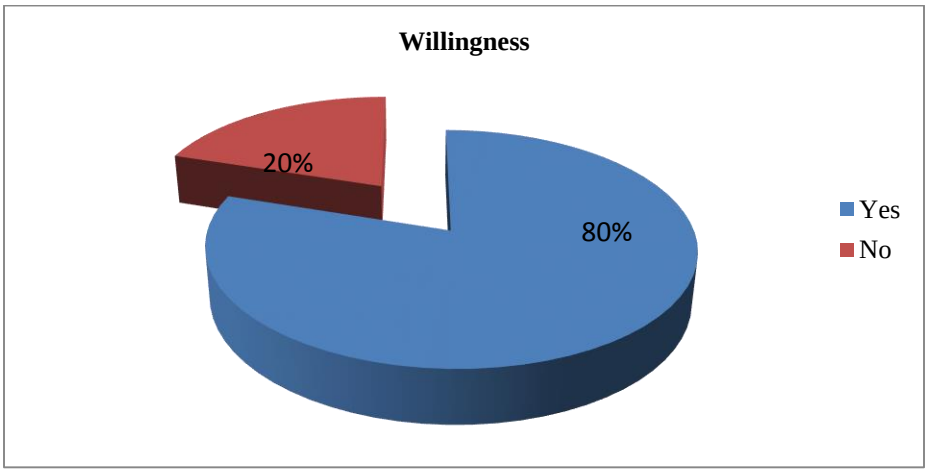


Figure 2: Descriptive Statistics Results of willingness to adopt chemical lasing service

Regression Model yielded following results.

The relationship between the willingness to adopt chemical leasing service and the selected demographic characteristics and other factors are shown in Table 5. Results suggest that there are statistically significant relationships between willingness to adopt chemical leasing service and essential prerequisites with chemical leasing service. The age and area were measure as range and the other all the variables were measure using five point liket scale.

Table 4.8: Estimated parameters and their statistical significance levels

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Age | -3.537 | 1.649 | 4.603 | 1 | .032* | .029 |
| | Area | 4.811 | 2.480 | 3.762 | 1 | .052 | 122.844 |
| | Outcome | 3.538 | 1.508 | 5.503 | 1 | .019* | 34.407 |
| | Cost | 3.005 | 1.383 | 4.719 | 1 | .030* | 20.178 |
| | Pressure | 5.111 | 2.232 | 5.246 | 1 | .022* | 165.850 |
| | Training | 5.951 | 2.569 | 5.368 | 1 | .021* | 384.132 |
| | Store | 4.532 | 1.967 | 5.310 | 1 | .021* | 92.903 |
| | Pay | 6.757 | 2.995 | 5.091 | 1 | .024* | 859.808 |
| | Method | 6.550 | 2.863 | 5.233 | 1 | .022* | 699.300 |
| | Safety | 8.334 | 3.537 | 5.552 | 1 | .018* | 4161.546 |
| | Other | 4.168 | 1.924 | 4.694 | 1 | .030* | 64.598 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Concern | -.634 | .676 | .878 | 1 | .349 | .531 |
| | Waste | 7.264 | 3.140 | 5.353 | 1 | .021* | 1428.196 |
| | Constant | -135.053 | 55.980 | 5.820 | 1 | .016* | .000 |

a. Variable(s) entered on step 1: Age, Area, Outcome, Cost, Pressure, Training, Store, Pay, Method, Safety, Other, Concern, Waste.

* = Statistically significant at the 0.05-level

Consequently farmer's age groups, expected outcome, cost of agrochemicals, family pressure, trained people, storing facilities, paying method, service method, safety concern, other inputs given and waste disposal method's easiness variables are the affected predictors. However all the factors which are considered in study were significant and affect to the farmers' willingness to adopt chemical leasing service.

Logit (Probability of willingness to adopt) = -135.03 -3.537(Age) + 3.538(Outcome) + 3.005(Cost) + 5.111(Pressure) + 5.951(Training) + 4.532(Store) + 6.757(Pay) + 6.550(Method) + 8.334(Safety) + 4.168(Other) + 7.264(Waste)

## Conclusion

Sri Lankan agro chemical consumption has grown rapidly while increasing harms to environment and health. The objectives of this study were to assess consumers' socio-economic/demographic characteristics, attitudes and perceptions on the willingness to adopt chemical leasing service. For estimation technique, Chi-square and binary logistic model were specified and analyzed using survey data in Nuwera Eliya district, Sri Lanka.

This study showed that about 78.9% of consumers in the sample willing to adopt this new innovative strategic model.

The findings of this study indicated that farmer's age, expected outcome of agrochemicals, cost of agrochemicals, and Farmers' family pressure, trained people in chemical application, agro chemicals storing facilities, are the demographic and socio economic factors determining significant of consumers' willingness to adopt chemical leasing service.

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# Analysis of combining ability and heterosis in tomato (*solanum lycopersicum)* using full diallel cross

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## Introduction

Tomato (Solanumlycopersicum) is the second most important vegetable crop next to potato. Tomato being one of the popular vegetable crops in Sri Lanka is preferred by farmers due to high economic returns, export potentials and nutritive value. Tomato is a rich source of vitamin A, C and minerals like Ca, P and Fe (Dhaliwalet al., 2003). Tomatoes are major contributors of antioxidants such as carotenoids (especially, lycopene and β-carotene), phenolics, ascorbic acid (vitamin C) and small amounts of vitamin E in daily diets (Raiet al., 2012).

In Sri Lanka, tomato is cultivated in more than 7137 ha, producing nearly 73917 t/year. (Department of Agriculture, 2010) The record lower yields are attributed to multiple of factors inclusive of elevated and frequent incidences of pest and diseases and inadequate accessibility to quality seeds (Ceylon Chamber of Commerce, 2011).

Most improvement programmes of many crops use diallel analyses as they provide breeders information on the genetic value of varieties as parents and to assess the gene action which can be directed at improving yield and other related quantitative characters (Vianaet al., 2001). Therefore, an understanding of the genetic control of characters and role of non-allelic interaction is essential to the breeder when deciding of the selection method and breeding procedure to follow (Esmail, 2007). From diallel analysis, plant breeders are able to gather information on heterosis and effect due to maternal, General Combining Ability (GCA) and Specific Combining Ability (SCA) of parents in crosses (Glover et al., 2005).

## Materials and method

Parents were obtained from the germplasm of the Plant Genetic Resource Centre (PGRC), Gannoruwa, Peradeniya.Seeds of the all possible crosses, reciprocals and Bhathiya were obtained from the Horticultural Crop Research and Development Institute (HoRDI), Gannoruwa from the maha season 2013/2014. All possible crosses and parents were shown in table 01.

Table 01: Table of diallel analysis

| M \ F | PH 12561 | PH 12585 | PH 12696 | PH 12835 |
|---|---|---|---|---|
| PH 12561 | | PH 12585 X PH 12561 | PH 12696 X PH 12561 | PH 12835 X PH 12561 |
| PH 12585 | PH 12561 X PH 12585 | | PH 12696 X PH 12585 | PH 12835 X PH 12585 |
| PH 12696 | PH 12561 X PH 12696 | PH 12585 X PH 12696 | | PH 12835 X PH 12696 |
| PH 12835 | PH 12561 X PH 12835 | PH 12585 X PH 12835 | PH 12696 X PH 12835 | |

These experiments included four parents, twelve F1 hybrid crosses and one reference line as Bhathiya. During the yala seasons of 2014 field experiments were conducted at HoRDI, Gannoruwa, only with total of 294 plants (Parents, F1 hybrids and Bhathiya as reference line).

The experiment was conducted in randomized complete block designs with two replications. All the management practices were done according to the department of agriculture recommendations. Finally fully ripened fruits were harvested.

Minitab 17 (1.0 version) software was used to analyse the variance of the twenty quantitative characters followed by the General linear model at the 0.05 probability level as mean separation technique. Analyzed mean values of the characters showing significant differences were further subjected to the analysis of combining ability by Griffing's (1956) Method, heterosis and heritability calculations.

**Data collection**

Phenotypically similar five tomato plants were selected from each variety at the seedling stage for data collection. Quantitative data were collected from those selected five plants under the vegetative, reproductive, yield and fruit quality traits for each variety.

**Results and discussion**

According to study PH 12561 X PH 12835 $F_1$ hybrid involved poor female into high male general combiner and performing positive specific combining ability with increase vigor of $F_1$ over the mid parent, better parent and standard variety. Therefore, it expressed as non-additive into additive gene interaction by performing low to moderate narrow sense heritability with slight environmental effect for the vegetative traits and yield traits. Similar results found by Frimpong*et al*., 2006.

Interpretation of the reproductive traits indicated the PH 12585 X PH 12835 $F_1$ hybrid involved average female into high male general combiner and executing positive specific combining ability through increase vigor of $F_1$ over mid parent, better parent and standard variety with

expression of the additive into additive gene interaction by performing low narrow sense heritability with low environmental effect.

In pursue of the research study, PH 12561 X PH 12696 $F_1$ hybrid elaborated poor female into high male general combiner and performing positive specific combining ability with increase vigor of $F_1$ over the mid parent, better parent and standard variety. Therefore, it interpreted as non-additive into additive gene interaction by performing low to moderate narrow sense heritability with slight environmental effect for the fruit quality traits.

Most of the considered quantitative traits were slightly affected by the environment due to the estimation of moderate narrow sense heritability values.

**Conclusion**

In pursue of the research study, PH 12835 parent interpreted as the best open pollinated parent. PH 12561 X PH 12835 $F_1$ hybrid indicated as the best $F_1$ hybrid for the vegetative and yield traits. PH 12561 X PH 12696 $F_1$ hybrid indicated as the best $F_1$ hybrid for the fruit quality traits.

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# Preservation of tomato (*Lycopersicon esculentum*) by dehydration for product development and utilization

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## Introduction

Tomato growers in the world experience high postharvest losses of fresh tomato supported by high perishability and low price of tomato during the peak production seasons due to production surplus and low product utilization of preserved tomato. Compared to the trends in the food industry the demand for dehydrated tomato is increasing rapidly both in domestic and in international markets (Purseglove *et al*., 2001). Dehydrated tomato topping is a condiment comprises with dehydrated tomato slices use to enhance the flavor and texture of salads, ranging from simple green salads to more elaborate versions.

Main objective of the study is the Preservation of Tomato (*Lycopersicon esculentum*) by dehydration for product development and product utilization. Specific objectives are dehydration using hot air drying, analysis of sensory, microbial and physiochemical parameters of dried samples and possibility of using dehydrated products for new product development and product utilization.

## Materials and methodology

The material used for this study is just ripen tomato (*Lycopersicon esculentum*) belongs to variety "Pathma".Preliminary studies were carried out to determine the best methods steaming and non-steaming methods. Best salt concentration was selected based upon the microbial counts and the moisture content. Best Sodium Meta bisulphite was selected based upon the organoleptic properties.

10g of dehydrated tomato, 50g of sugar, 400mL of water, 20g of Corn flour, 15mL of vinegar, 10mL of citric acid were used according to the developed methodology. Dehydrated tomato topping with brix value 25 was developed using the methods developed through the preliminary trials. Brix value was adjusted to 25 during cooking. Final product was stored under room temperature in sterilized glass bottles.

The microbial evaluation, proximate analysis, analysis for organoleptic properties and physico - chemical analysis for final product was conducted to ensure the product safety and quality.

## Results and Discussion

### Microbiological tests

Microbiological tests were carried by the Veterinary Research Institute (VRI), Peradeniya to ensure the safety of the final product for the consumers.

Table: Results of the microbiological tests for dehydrated tomato topping with brix value 25

| Microbiological test | Results (CFU/g) |
|---|---|
| *Salmonella* spp. | Negative |
| *Staphylococcus aureus* | Negative |
| *E.coli* | Negative |
| Aerobic Plate Count(APC) | $5.0 \times 10^0$ |

Based on the Sri Lankan standards for the microbiological tests the Aerobic Plate Count should be less than $5\times10^5$.The absence of the pathogenic bacteria is a requirement of Sri Lankan standards for microbial tests.

**Proximate Composition of the Final Product**

Table: Proximate composition of the final product

| Parameter | Composition |
|---|---|
| Appearance | Normal |
| Moisture % | 73.0 |
| Ash % | 0.1 |
| Crude protein % | 0.5 |
| Ether extract (Fat) | 0.0 |

The most important feature of the product is free from Ether extract. Most toppings are rich in fats. Hence, the developed product is a favorable substitute for toppings rich in fats as a food additive for people who are advised to use fat free diets for therapeutic purposes. The standards for proximate composition of Tomato toppings are not mentioned in Sri Lankan Standards.

**Sensory Data of Shelf Life Evaluation**

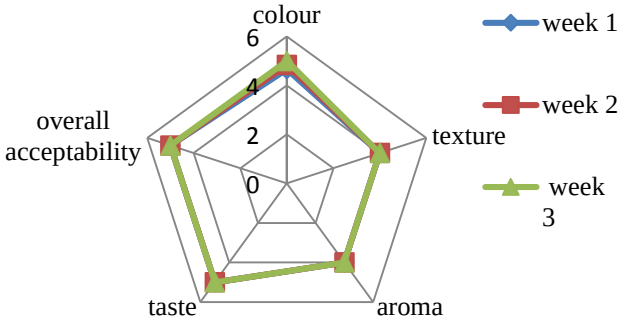


Figure 1: Web diagram illustrates the changeability of sensory attributes with time

The dehydrated tomato topping with the brix value of 25 has obtained the highest acceptability for overall appearance and taste for the duration of three weeks. The acceptability for the aroma and the texture of the product has decreased continuously for three sensory evaluation tests. The acceptability for the colour has increased from week one to week three due to the gradual increment of the brix value, pH and titratable acidity of the product with the time.

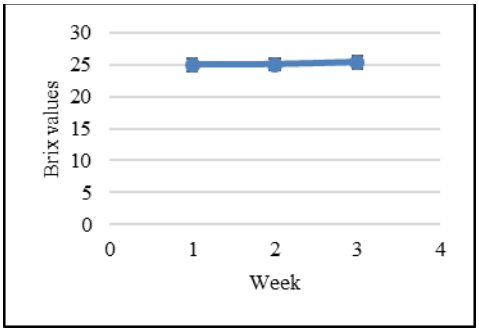


Figure 2: Change in mean Brix value of dehydrated tomato topping during the storage period under refrigerated conditions

**Physico-Chemical Analysis**

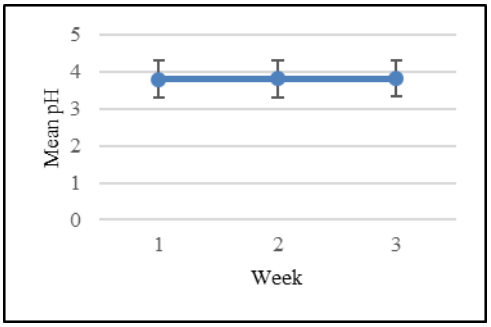


Figure 3: Change in mean pH value of dehydrated tomato topping during the storage period under refrigerated conditions

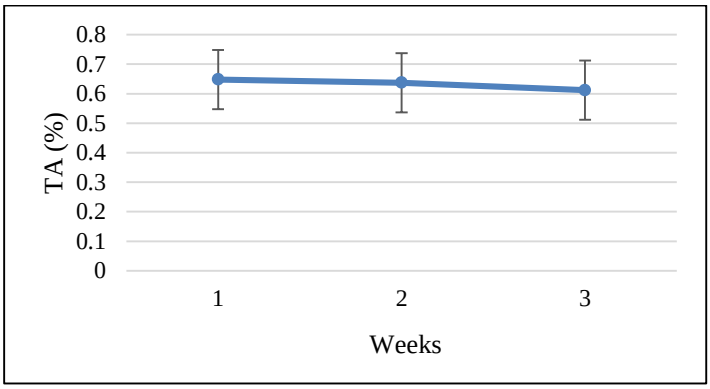


Figure 4: Change in mean TA value of dehydrated tomato topping during the storage period under refrigerated conditions

Brix values and pH values of the final product has increased slightly from first week to third week with the aging of the product while the titratable acidity of the product has decreased. At the end of the third week the pH lays on the value of 3.82.Hence it lays below the value of 4.4 which is recommended as the maximum pH value for the food products. Hence the product is safe for the consumption for three weeks period. The reason for the overall reduction of titratable acidity of the product is the increment of the pH value of the product with aging.

## Conclusion

The preservation of tomato is very much important to address the market gap in between the market demand and supply. Dehydration can be identified as one method of preservation. The tomato samples should be pretreated with 2% salt to enhance the efficiency of the dehydration process. The dehydrated tomato topping with the brix value of 25 gives the best sensory attributes. The brix value is the main parameter adjusted in the dehydrated tomato topping by addition of sugar.50g of sugar is required for the production of 200ml of the dehydrated tomato topping. The pH value is adjusted to the value of 3.8 by addition of citric acid. The pH should be kept below the value of 4.4.The dehydrated tomato topping is a fat free food additive which extends the range of value addition to tomato fruits.

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# Study on response of rice varieties to different nitrogen fertilizer levels

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## Introduction

Rice (Oryza sativa L.) is the single most important crop and the staple food of more than three billion people or more than half of the world's population. Paddy is cultivated as a wetland crop in all districts. Direct or indirect involvement for paddy sector is more than 30 % of the total labour force (Wickramasinhe and Wijewardena, 2000). Rice provides 45% total calorie and 40% total protein requirement of an average Sri Lankan (Department of Agriculture,2010).The areaunder paddy production in yalaand maha was 1,671,054 Mt and 2,629,566 Mt respectively (Department of Census and Statistics, 2010). Nitrogen, phosphorous and potassium are the three major nutrients required for the rice plant. Nitrogen (N) is one of the essential macro -nutrients for rice growth and one of the main factors to be considered for developing a high-yielding rice cultivar. Nitrogen increases plant height, panicle number, leaf size, spikelet number, and number of filled spikelets, which largely determine the yield capacity of a rice plant. Panicle number is largely influenced by the number of tillers that develop during the vegetative stage. Rice plants require nitrogen during the tillering stage to ensure a sufficient number of panicles and reproductive to grain filling. Nitrogen imbalance in soil produces low fertilizer use efficiency, low yields and low farmer profit.Main nitrogen loss mechanisms are volatilization of ammonia (NH3), leaching loss of nitrate (NO3-), loss through denitrification and soil erosion (Choudhury and Kennedy, 2005).Therefore, optimum level of nitrogen fertilizer should be applied to get maximum yield of paddy cultivation and utilize nitrogen fertilizers effectively (Fageria and Baligar, 2003).

## Materials and Methods

This study was conducted at the Rice Research Development Institute (RRDI) at Batalagoda in Kurunagala district, Sri Lanka. Fertilizers used were urea as the Nitrogen source, and others; Triple super phosphate and Murate of Potash. The experiment was comprised with sixteen treatments. Nitrogen fertilizer was applied as 0, 50, 100 and150 kg N ha-1. Four rice varieties, Bg 1350 (V1), Bg 997 (V2), Bg 379-2 (V3) and Bg 450 (V4) were tested. These four rice varieties are in age group of four to four and half months.Sixty four plots were arranged according to the split plot design with sixteen treatments and four replicates.

Plant height, number of tillers per hill, plant greenness, number of days for 100 % flowering of rice varieties, dry weight of shoot parts, plant nitrogen content, number of panicles per hill and grain yield were measured against different nitrogen levels.

**Result and Discussion**

As the results showed (Table 1) there was a significant effect ($P<0.005$) among the treatments for the plant height, number of tillers per hill, plant greenness, number of days for 100 % flowering of rice varieties, plant nitrogen content, number of panicles per hill and grain yield. There is no statistically significant difference among the levels of nitrogen and variety with dry weight of shoot parts.

Table 1:Means of plant parameters for different treatments

| Treatments | Plant height | Number of tillers | Plant SPAD reading | Dry weight of shoot parts | Grain weight | Number of dates of 100 % flowering | Nitrogen content of shoot parts | Number of panicles per hill |
|---|---|---|---|---|---|---|---|---|
| N0V1 | 64.86$^{a}$ | 7.26$^{a}$ | 27.49$^{a}$ | 11.43$^{a}$ | 2.35$^{a}$ | 79.30$^{b}$ | 2.12$^{a}$ | 7.73$^{a}$ |
| N1V1 | 75.46$^{ab}$ | 9.66$^{a}$ | 33.21$^{ab}$ | 21.16$^{a}$ | 3.58$^{ab}$ | 79.33$^{a}$ | 2.70$^{a}$ | 9.66$^{a}$ |
| N2V1 | 78.33$^{a}$ | 12.13$^{a}$ | 36.90$^{b}$ | 24.12$^{a}$ | 3.71$^{c}$ | 78.70$^{bc}$ | 3.17$^{a}$ | 9.53$^{a}$ |
| N3V1 | 83.13$^{a}$ | 12.40$^{a}$ | 38.32$^{b}$ | 26.55$^{a}$ | 4.21$^{b}$ | 80.70$^{a}$ | 3.26$^{b}$ | 11.46$^{a}$ |
| N0V2 | 64.80$^{a}$ | 6.60$^{a}$ | 28.25$^{a}$ | 12.66$^{a}$ | 2.75$^{a}$ | 72.00$^{c}$ | 2.56$^{a}$ | 7.26$^{ab}$ |
| N1V2 | 77.73$^{a}$ | 8.33$^{a}$ | 34.73$^{a}$ | 19.12$^{a}$ | 3.91$^{a}$ | 71.00$^{b}$ | 3.15$^{a}$ | 8.66$^{a}$ |
| N2V2 | 78.00$^{a}$ | 9.80$^{ab}$ | 37.55$^{b}$ | 25.74$^{a}$ | 4.91$^{a}$ | 75.70$^{c}$ | 3.50$^{a}$ | 9.00$^{a}$ |
| N3V2 | 80.33$^{ab}$ | 10.93$^{b}$ | 38.09$^{b}$ | 28.79$^{a}$ | 5.31$^{a}$ | 75.33$^{b}$ | 3.78$^{a}$ | 9.86$^{a}$ |
| N0V3 | 51.40$^{b}$ | 7.26$^{a}$ | 28.15$^{a}$ | 14.69$^{a}$ | 2.45$^{a}$ | 85.00$^{a}$ | 2.54$^{a}$ | 7.13$^{ab}$ |
| N1V3 | 61.93$^{c}$ | 9.66$^{a}$ | 30.54$^{a}$ | 22.2$^{a}$ | 3.65$^{ab}$ | 81.33$^{a}$ | 3.29$^{a}$ | 9.00$^{a}$ |
| N2V3 | 61.13$^{b}$ | 10.86$^{ab}$ | 34.10$^{c}$ | 22.01$^{a}$ | 3.65$^{c}$ | 85.00$^{a}$ | 3.52$^{a}$ | 9.13$^{a}$ |
| N3V3 | 69.06$^{c}$ | 12.60$^{a}$ | 38.16$^{b}$ | 28.53$^{a}$ | 5.00$^{a}$ | 81.70$^{a}$ | 3.59$^{ab}$ | 11.06$^{a}$ |
| N0V4 | 62.73$^{a}$ | 6.26$^{a}$ | 30.37$^{a}$ | 12.39$^{a}$ | 2.56$^{a}$ | 80.00$^{b}$ | 2.52$^{a}$ | 5.60$^{a}$ |
| N1V4 | 68.73$^{bc}$ | 9.26$^{a}$ | 32.98$^{ab}$ | 19.75$^{a}$ | 3.16$^{b}$ | 80.33$^{a}$ | 3.19$^{a}$ | 8.93$^{a}$ |
| N2V4 | 76.46$^{a}$ | 9.20$^{a}$ | 40.26$^{a}$ | 22.30$^{a}$ | 4.20$^{b}$ | 81.00$^{b}$ | 3.29$^{a}$ | 8.93$^{a}$ |
| N3V4 | 76.73$^{b}$ | 11.53$^{ab}$ | 43.72$^{a}$ | 24.95$^{a}$ | 4.76$^{ab}$ | 83.33$^{a}$ | 3.75$^{a}$ | 9.93$^{a}$ |

Means followed by the same letter in the same column are not significantly different at $P< 0.05$.

**Conclusions**

The results showed that the responses to application of nitrogen fertilizer vary among the rice varieties.

Plant height , number of tiller per hill, plant greenness, dry weight of shoot parts, plant nitrogen content of shoot parts, grain yield and number of panicles per plant of four rice varieties increase with increasing level of nitrogen fertilizer and respond positively.

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# Factors affecting on the integrity and sealing of flexible packaging

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## Introduction

In biscuit manufacturing, quality assurance plays a significant role in order to deliver a product that will attract the customers and profit gaining of the industry is closely related with the quality of packaging operations (Manly, 2002). There are various types of packaging materials that is being used for biscuit packaging but at present, flexible packaging materials are used prominently because of its good barrier properties, space saving, ease of operation and disposability etc. End product package integrity is important when assuring quality of the product throughout the shelf life (Robertson, 2012). At packaging, sealing defects may result damaged end products which will eventually absorb moisture and the biscuits may become stale and deteriorated along with shelf life. To prevent that, suitable machine settings of the packaging machine should be maintained and monitored.Objectives of this study are to find the best suitable machine setting range for two types of wrappers, metalized wrapper and laminated wrapper and to find the effect of Accelerated life testing on the package integrity, moisture absorbance and rancidity.

## Methodology

In this study, the integrity of end products belonged to two different types of flexible packaging materials (metalized and laminated wrapper), which was produced to different sets of temperature settings were monitored. From the selected wrappers, material combination of metalized wrapper (trade name Metalized BOPP/ CPP film) is 20 BOPP/ 25 MCPP and laminated wrapper (trade name BOPP/ CPP) consist 30 BOPP/ 25 CPP. Selected metalized wrapper is being using for Soft dough type 1(round) 75g product and laminated wrapper is being using for Soft dough type 2(rectangular) 100g product. The integrity of biscuit package is measured by subjecting the samples in to Leak tester. The sample packet was submerged in the water chamber of the leak tester and gradually the vacuum of the head space of the water chamber was created and was increased which resulted the expansion of the packet. The value of the vacuum pressure at which the package integrity gets terminated (either by bubble emission from the weakest point of seal or bursting of the package) was taken as the response measurement. Preliminary data base was created for five weeks by testing sixty biscuit packets of metalized and laminated wrapper each from morning and evening shift for its integrity by subjecting those to leak tester. The treatment was taken as the machine setting values (sealing temperature values) at which the biscuit packages were produced(RL1= roller 1, RL2= roller 2, UJ= upper jaw, LJ= lower jaw). The response variable was the vacuum pressure value at which the package integrity was terminated when subjected to leak tester.Those best treatments from each metalized wrapper and laminated wrappers were then subjected to accelerated life testing (ALT) by incubating under 45°C for eight weeks. Weekly the biscuit packet samples from each wrapper were tested for its integrity, moisture content, pH and rancidity.

**Results and Discussion**

Table 01: Preliminary analysis results for metalized wrapper

| Date | Shift | Treatments | RL1 (°C) | RL2 (°C) | U J (°C) | L J (°C) | Mean (kPa) | p value | Significance |
|---|---|---|---|---|---|---|---|---|---|
| 4.6.14 | 1st | MS1 | 186 | 192 | 164 | 161 | 39.34 | 0.996 | Not significant |
| | | MS2 | 182 | 192 | 162 | 160 | 39.69 | | |
| | | MS3 | 183 | 192 | 164 | 161 | 39.31 | | |
| | 2nd | MS1 | 184 | 192 | 164 | 161 | 39.46 | 0.039 | Significant MS2-MS1 |
| | | MS2 | 189 | 197 | 164 | 163 | 50.14 | | |
| | | MS3 | 191 | 198 | 164 | 163 | 47.43 | | |

There was significant effect from treatment in the second shift as the p value is 0.039 and difference between the treatments MS2 and MS1 in the second shift was significant.

Table 02: Preliminary analysis results for laminated wrapper

| Date | Shift | Treatments | RL1 (°C) | RL2 (°C) | U J (°C) | L J (°C) | Mean (kPa) | p value | Significance |
|---|---|---|---|---|---|---|---|---|---|
| 14.7.2014 | 1st | MS1 | 191 | 194 | 148 | 152 | 23.76 | 0.161 | Not significant |
| | | MS2 | 195 | 199 | 160 | 162 | 31.42 | | |
| | | MS3 | 194 | 199 | 159 | 162 | 32.15 | | |
| | | MS4 | 193 | 199 | 160 | 161 | 23.23 | | |
| 15.7.2014 | 1st | MS1 | 192 | 196 | 160 | 163 | 37.48 | 0.719 | Not significant |
| | | MS2 | 192 | 196 | 162 | 163 | 37.74 | | |
| | | MS3 | 193 | 196 | 164 | 162 | 40.97 | | |

As obtained p values for the treatments, 0.161 and 1.719 there were no significant effect from the treatments. To prepare samples for accelerated life testing, MS3 treatment value in first shift of 15.7.2014 was taken as best treatment because it had the highest mean of response variable (RL1= 193°C, RL2= 196°C, UJ= 164°C, LJ= 162°C).

When the biscuit samples with metalized wrapper were subjected to accelerated life testing, for the best machine setting it showed low moisture absorbance and vacuum pressure values at the termination of package integrity were above 40 kPa. Mean vacuum pressure values increased from 43.64 kPa to 48.91 kPa up to fifth week and it was gradually decreased to 36.16 kPa on last and eighth week of accelerated life testing.Moisture absorbance was low up to sixth week from 2.66% to 2.91% then it was increased to 3.48% at the end of eighth week. pH variations of the sample were low which was between 7.07 and 7.55 for the tested eight weeks and it showed negative results when tested for rancidity.

There was no treatment effect from the laminated wrapper and samples for accelerated life testing were produced according to the machine setting which gave the highest mean vacuum pressure value when checked for the package integrity. In accelerated life testing, mean vacuum pressure values showed minimum variation unlike the data obtained for metalized wrapper and the mean vacuum pressure values were within the range of 40.57 – 41.54 kPa. Moisture content gradually increased from 2.36% to 2.69%but pH values decreased from 7.84 to 6.68. There was slight indication of rancidity on the last week of testing

**Conclusions**

Best machine setting for metalized wrapper was MS2 with temperature values in °C, RL1= 189, RL2= 197, UJ= 164, LJ= 163 and best machine setting for laminated wrapper was RL1= 193°C, RL2= 196°C, UJ= 164°C and LJ= 162°C.

Weakest sealing point for metalized wrapper was middle of center seal and for laminated wrapper it was the serrated edge of cutter seal.

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Packaging of Cereals, Snack Food and Confectionary. In: Robertson, Gordon L. (ed) (2012). Food Packaging: Principles and Practice. CRC Press, USA

# Selection of an effective biofilmed biofertilizer formulation and best potting medium for anthurium (*Anthurium andraeanum*)

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## Introduction

Anthurium is identified as one of the crops prioritized for the development and export promotion in Sri Lanka (Kelegama, 2001). Optimum growth and flowering of Anthurium mainly depend on potting medium, fertilizer and light levels (Higaki et al, 1994). Potting medium rich in nutrients and effective fertilizers can be used for the optimum growth of this plant. Beneficial biofilm based biofertilizers called biofilmed biofertilizers (BFBFs) have been introduced recently (Seneviratne et al., 2010). Present study was focused to select an effective biofilmed biofertilizer formulation and evaluate the comparative effect of different potting media on vegetative growth of Anthurium andreanum plant.

## Methodology

The present study was carried out at the Royal Botanic Gardens, Peradeniya. Two experiments with different treatments were conducted during this study. First experiment was conducted under shade house conditions with different fertilizer treatments; 50 % chemical fertilizer (CF), 50 % CF + BFBF and100 % CF recommended for Anthurium was selected as the control. In the second experiment, four different potting media (inert particle mixture, coir chips, leaf litter with sand, control) were used and the existing potting medium, which was used at the Royal Botanic Gardens, Peradeniya was taken as the control. Different BFBF with 50 % CF application was under taken at one week interval for the plants of the first experiment and 50 % CF application was under taken at one week interval for the plants of second experiment. Initial data were collected before the plants establishment and final vegetative growth parameters were measured after three months of plant establishment in both experiments. Plant height (cm), plant weight (g), total root length (cm), leaf number, leaf area, root number and the chlorophyll content were considered as the vegetative growth parameters. Treatments were arranged in a Complete Randomized Design (CRD). Mean separation was conducted using the Tukey method ($P< 0.05$). MINITAB 16 statistical package (Minitab Inc.) was used for data analysis in both experiments.

## Results and Discussion

### Experiment 01

As indicated in the Table 1, treatment 16 (BF4 alone treatment) recorded the highest rank value over the other 16 treatments. Thus, the treatment 16 was effective in the increment of all

vegetative growth parameters in Anthurium plant. As indicated in Table 1, treatment 13 (50 % CF) significantly contributed to increment of plant growth and development than treatment 14 (100 % CF).

Table 1: Ranked data (increment percentages of vegetative growth parameters) of experiment 01

| Treat-ments | Fresh Weight (g) | Number of Roots | Total Root Length (cm) | Number of Leaves | Plant Height (cm) | Chloro-phyll Content | Leaf Area | Sum of Rank | Final Rank |
|---|---|---|---|---|---|---|---|---|---|
| $BF_1$ + 50 % CF | 1 (58 $^{e}$) | 2 (15$^{c}$) | 1 (0$^{b}$) | 1 (0$^{d}$) | 1(33$^{abcd)}$ | 6 (13$^{b}$) | 3 (42$^{b}$) | 18 | 1 |
| $BF_2$ + 50 % CF | 2 (62 $^{de}$) | 6 (58$^{abc}$) | 2 (1$^{b}$) | 2 (53$^{abcd}$) | 12 (49$^{abcd}$) | 9 (26$^{ab}$ | 9 (40$^{b}$) | 43 | 3 |
| $BF_3$ + 50 % CF | 12 (197$^{ab}$) | 12 (84$^{abc}$) | 3 (25$^{ab}$) | 3 (18$^{bcd}$) | 4 (60$^{abc}$) | 13 (26$^{ab}$) | 8 (80$^{ab}$) | 62 | 7 |
| $BF_4$ + 50 % CF | 15 (250$^{ab}$) | 17 (134$^{a}$) | 13 (111$^{a}$) | 13 (32$^{bcd}$) | 8 (42$^{abcd}$) | 7 (61$^{a}$) | 17 (60$^{b}$) | 96 | 13.5 |
| $BF_5$+ 50 % CF | 11 (198$^{abcd}$) | 8 (66$^{abc}$) | 8 (66$^{a}$) | 8 (37$^{bcd}$) | 9 (44$^{abcd}$) | 8 (29$^{ab}$) | 6 (11$^{ab}$) | 68 | 8 |
| $BF_6$ + 50 % CF | 8(169$^{ab}$) | 1(13$^{bc}$) | 10 (81$^{a}$) | 10 (28$^{bcd}$) | 7 (21$^{cde}$) | 4(9$^{b}$) | 2 (98$^{ab}$) | 50 | 4 |
| $BF_7$ + 50 % CF | 5(110$^{ce}$) | 14 (105$^{a}$) | 16 (131$^{a}$) | 16 (4$^{cd}$) | 2 (10$^{de}$) | 2 (2$^{b}$) | 1 (56$^{b}$) | 61 | 6 |
| $BF_8$ + 50 % CF | 3(94$^{cde}$) | 15 (116$^{ab}$) | 6 (58$^{ab}$) | 6 (9$^{cd}$) | 3 (3$^{e}$) | 1 (24$^{ab}$) | 7 (42$^{b}$) | 43 | 2 |
| $BF_9$ + 50 % CF | 10 (190$^{abcd}$) | 13 (96$^{ab}$) | 14 (119$^{ab}$) | 14 (71$^{ab}$) | 16 (20$^{bcde}$) | 3 (30$^{b}$) | 13 (106$^{ab}$) | 92 | 12 |
| $BF_{10}$+ 50 % CF | 6 (123$^{bcde}$) | 9 (73$^{abc}$) | 9 (70$^{a}$) | 9 (27$^{bcd}$) | 6 (63$^{abc}$) | 14 (38$^{ab}$) | 16 (53$^{b}$) | 73 | 9.5 |
| $BF_{11}$+ 50 % CF | 4 (109$^{cde}$) | 7(64$^{abc}$) | 7 (62$^{a}$) | 7 (40$^{abcd}$) | 10 (60$^{abc}$) | 12 (30$^{ab}$) | 12(171$^{a}$) | 73 | 9.5 |
| $BF_{12}$ +50 % CF | 17 (293$^{a}$) | 4 (41$^{abc}$) | 11 (95$^{a}$) | 11 (93$^{a}$) | 17 (59$^{abc}$) | 11 (26$^{ab}$) | 11(78$^{ab}$) | 96 | 13.5 |
| 50 % CF | 13 (218$^{abc}$) | 11 (79$^{ab}$) | 1 (100$^{a}$) | 12 (57$^{abc}$) | 13 (53$^{abc}$) | 10 (28$^{ab}$) | 10 (216$^{a}$) | 99 | 15 |
| 100 % CF | 7 (127$^{bcde}$) | 3 (35$^{abc}$) | 4 (33$^{ab}$) | 4 (25$^{bcd}$) | 5 (21$^{bcde}$) | 5 (33$^{ab}$) | 5 (146$^{ab}$) | 53 | 5 |
| $BF_3$ alone | 14 (249$^{ab}$) | 5 (35$^{abc}$) | 15 (129$^{a}$) | 15 (51$^{abcd}$) | 11 (122$^{a}$) | 17(35$^{ab}$) | 17 (208$^{a}$) | 108 | 16 |
| $BF_4$ alone | 16 (270$^{a}$) | 16 (57$^{abc}$) | 17 (186$^{a}$) | 17 (66$^{ab}$) | 14 (91$^{ab}$) | 16 (18$^{b}$) | 16 (165$^{ab}$) | 113 | 17 |
| $BF_{10}$ alone | 9 (172$^{abcd}$) | 10 (77$^{abc}$) | 5 (53$^{a}$) | 5 (68$^{ab}$) | 15 (78$^{abc}$) | 15 (19$^{b}$) | 15 (160$^{ab}$) | 76 | 11 |

**Experiment 02**

According to the Table 2, the highest rank recorded in treatment 1 (Inert particle mixture). Treatment 3 (Leaf litter with sand) was better than the treatment 4 (control) for the growth of Anthurium andreaenum plant under prevailing climate condition. Coir chips potting medium was seen to prove less effective for better plant growth due to its less contribution for the availability of nutrients.

| Treatments | Fresh Weight (g) | No. of Roots | Total Root Length (cm) | No.of Leaves | Plant Height (cm) | Chloro-phyll Conte-nt | Leaf Area | Sum of Rank | Final Rank |
|---|---|---|---|---|---|---|---|---|---|
| Inert Particle Mixture | 4 ($197^{a}$) | 2 ($23^{a}$) | 3 ($61^{a}$) | 3 ($36^{a}$) | 4 ($50^{a}$) | 4 ($33^{a}$) | 4 ($142^{a}$) | 24 | 4 |
| Coir Chips | 1 ($81^{a}$) | 1($5^{a}$) | 1 ($22^{a}$) | 2 ($35^{a}$) | 1 ($3^{c}$) | 2 ($10^{a}$) | 1($48^{b}$) | 9 | 1 |
| Leaf Litter with Sand | 2 ($124^{a}$) | 3 ($32^{a}$) | 2 ($46^{a}$) | 4 ($41^{a}$) | 3 ($29^{ab}$) | 3 ($12^{a}$) | 3 ($68^{b}$) | 20 | 3 |
| Control | 3 ($132^{a}$) | 4 ($54^{a}$) | 4 ($67^{a}$) | 1 ($19^{a}$) | 1($10^{bc}$) | 2 ($8^{a}$) | 2 ($49^{b}$) | 17 | 2 |

Table 2: Ranked data of (increment percentages of vegetative growth parameters) experiment 02

**Conclusions**

According to the first experiment, BFBF alone treatments (BF4 alone treatment and BF3 alone treatment) improved the vegetative growth of *Anthurium andreanum* plant. Thus, BFBF alone treatments highly influenced than the BFBF combined with 50 % CF. In apparent, that the 50 % CF significantly contributed to increment of plant growth and development than 100 % CF. This indicated, reduction of 50 % CF not negatively affected to vegetative growth parameters in Anthurium. Results of second experiment suggested that potting medium of inert particle mixture (charcoal, coir dust, sand and bricks particles (1:1:1:1) can be recommended as a standard potting medium for *Anthurium andreanum* to maintain satisfactory plant growth, development and ultimately plant quality.

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# Studying the effects of *Paracoccus marginatus* (Mealybug) attack on forming of *Tagets spp.* (Indian Marigold) flower

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## Introduction

Merigold (Asteraceae: *Tagets spp.*) is native plant to America and Mexico which is introduced to Sri Lanka for ornamentation. Widely grows in home gardens throughout the country, cultivates for cut-flowers and use as insects repellant (Vennila *et al*., 2011). The plant use to medicinal remedies and cultivates as a food crops in some other countries but not in Sri Lanka.

Managing Mealybug (Hemiptera: Pseudococcidae; *Paracoccus marginatus*) insects presents unique challenges. Mealybugs are polyphagous and multiply on different hosts. These have been recorded on many plant species including field crops, vegetables, ornamentals, weeds, bushes and trees in Sri Lanka. Important host plants include okra, holly hock, brinjal, potato, maize, sorghum, groundnut, pigeon pea, sunflower, beetroot, mulberry, Amaranthus spp, Marigold and cucurbits (Anon, 2008). The severity of problem may be estimated from the fact that this insect produces as many as 15 generations per year. The nymphs and adults suck plant sap from tender shoots, leaves and even hard tissues including main stem and branches and cause damage (Anon, 2008) which cause direct plant injury by feeding on plant fluids or sap in the vascular tissues, primarily the phloem or mesophyll or both, with their piercing-sucking mouthparts. In addition, Mealybugs excrete a clear sticky liquid called honeydew which serves as a growing medium for black sooty mold fungi that is secreted on to the leaves which interferes with photosynthesis (Lysandrou *et al.*, 2012). As a result of Mealybug attack, plants become stunted and in severe cases may die. They may also inject a toxin. This may cause leaf yellowing, plant stunting, and wilting. Mealybugs are also capable of transmitting diseases, including viruses. Mealybugs tend to congregate in large numbers at leaf junctures where the petiole meets the stem, on leaf undersides, on stem tips, and under the leaf sheaths. Mealybug is origin in Central America (Williams and Granara, 1992) has its spread at the Caribbean and Ecuador, Chile, Argentina, Brazil, Pakista, India, Nigeria, China, Australia and Sri Lanka (Prishanthini and Laxmi, 2009). Such a vast and fast distribution of Mealybug across the globe largely during the past few years and its economic damage to several crops make it necessary to characterize the ecological factors associated with the pest. In this study, evaluate Mealybug attack on the damage of marigold flower forming.

## Materials and Methods

Seeds of Indian Merigold were purchased from the Seed and Planting Material Division, Huggala botanical garden, Sri Lanka. In this study was conducted in green house at the Department of Agriculture Biology, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka. Four pot replicates were conducted on Merigold plants that was

infested with Paracoccus marginatus. Two pots were used as controls. Potting medium was taken 1:1:1 Sand, compost and topsoil and two Merigold plants were cared in each pot. At the flowering stage, two adults of Paracoccus marginatus were taken from infected Papaya plant (*Carica papaya*) and introduced to the every branch of Merigold plant. Data were collected from maturity stage of the flower (after blooming 3days). Data regarding Merigold flowers diameter reduction were subjected to analysis mean average value and compared with the control. Experiment was repeated 3 times.

**Results and Discussion**

Mean average flower diameter in control pots was 5.85 cm and average mean flower diameters of the infected plants were 3.5 cm. It showed significant reduction of flower formation which were attacked by mealy bug. Merigold flowers were used as insects repellant in biologically. In this study, 59.8% of flower were damaged by Mealy bugs' activities (Figure 1;d,e,f,). Same result was also showed in many ornamental plant species (Vennila *et al*., 2011; Janet *et al*, 2009). Merigold flowers infected by Mealy bug showed reduction of number of petals, decrease the bud size and further infected changed the colour to brown and died.


**Figure 1:** Different stages of Mealy bug infected flowers
( a, Mealybug infected flower; b, Indian Merigold Plant(control); c, Indian Merigold flower without infected Mealybug; d, Mealybug associated with ants; e and f, reduction of flower formation of infected flowers)

The present results of the ants association with mealybug ( Figure1;d) were in close conformity with the report of earlier workers who reported the association of *S. geminate* with *Phenacoccus solenopsis* Tinsley association of *S. geminata* with homopterans (Gowda *et al.*, 2014). During the present study different ant species were found to transfer the mealybugs from one plant to another. This finding is in agreement with Genter (1925) who found that the ant, *Camponotus lineolatta* (Say) transferring the grape mealybug, *Pseudococcus maritimus*. Saini *et al.* (2009)

also noticed that ants were responsible for quick colonization of *P. solenopsis* to new areas. Smith (1928) reported that ants collected during the surveys comprised *Tapinoma sessile* Say, *Pheidole* sp., and *Technomyrmex* sp. (Hymenoptera: Formicidae).

**Conclusion**

Mealybugs severly damage to Indian Merigold flower production. Researchers and farmers should have to use control measures to prevent Mealybug and ants entering to the plantation. Special attention should be paid when growing Marigold in the crop field as an insect repellant.

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# Consumer preference for quality attributes of rice

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## Introduction

Paddy cultivation serves as the major coping strategy for 800,000 families in Sri Lanka. The average paddy productivity has reached to 4.3 t/ha in 2013 while the annual per capita consumption is 116 kg/year (DCSL, 2013). Rice remains as the staple food of the country and the consumers have different preference for different quality attributes of rice through which they derive consumer utility. Hence, it is important to identify the quality attributes of rice preferred by different consumer segments. This information is of vital importance for farmers to enhance the supply catering to the consumer demand. Therefore, the main objective of this study was to identify different rice quality attributes and their levels as valued by the consumer choice.

## Methodology

The study was conducted in Gampaha District in 2014 with 63 consumers selected using stratified random sampling. Four quality attributes and three levels per each were selected using focus group discussion. A fractional factorial design (1/3) was used to reduce the full profile. Data was collected using Semi structured pre-tested conjoint questionnaire. The significance of the selected attributes was tested using ANOVA and part-worth utilities were estimated by a logistic regression. The relative importance of each attributes was also calculated.

## Empirical model

Consumer preference is non parametric attribute. Conjoint analysis (CA) is the most widely used method to analyse consumer preference. A set of hypothetical products is defined by combining product attributes at various levels. Consumers are asked to evaluate their overall preference rating or ranking of the hypothetical products. The final step of CA involves choosing an appropriate composition model and estimating the buyer's part-worth utilities (Harrison, 1998).

***Part-Worth Utility Model***

$R_i = G + W_1D_1 + W_2D_2 + W_3D_3 + W_4D_4 + W_5D_5 + W_6D_6 + W_7D_7 + W_8D_8 + e_i$ ……(4)

$R_i$ = preference rating for the i$^{th}$ respondent

$W_i$ , i = 1,2..n are part-worth estimates associated with respective levels of product attributes.

$D_i$ , i = 1,2..n are dummy variables for significant levels of attributes

$e_i$ = error term

***Relative Importance (RI)***

RI = (Utility Range/ Σ utility ranges of all attributes) *100

## Random Utility Theory

Once the data are choice-based, researchers use random-utility models in which the basic idea is the assumption of utility maximization (Hauser and Rao, 2002). The attributes and levels are

described in Table 1. Attributes were selected using focus group discussion. Each selected attributes consist with 3 levels.

Table 1: Description of attributes

| | Attributes | | | |
|---|---|---|---|---|
| | Degree of Milling | Shape | Tenderness | Price |
| Levels | Brown | Short Round | Soft | <Rs.60/kg |
| | Partially Polished | Long Bold | Average | Rs.60-70/kg |
| | Fully Polished | Long Slender | Hard | >Rs 70/kg |

**Results and Discussion**

Among the Selected 63 rice consumers there was a large portion of female rice consumers (65%) where as a little portion of male rice consumers (35%) were participated for the survey. Most of the consumers (65%) were between the age of 25 – 50 years, 25% of participants were below 25 years and remain 10% was over 50 years old.

When consider about the rice consumption majority (56%) of the sample is consuming rice for all three meals and 44% of consumers consume rice only twice a day. Among the respondents 52% make the decision to purchase rice for their families. The significance of the selected attributes are shown in Table 2.

Table 2: ANOVA Results for quality attributes

| Attribute | Degrees of Freedom | Sum of Squares | Mean Sum Squares | F Value | Pr>F |
|---|---|---|---|---|---|
| Degrees of Milling | 2 | 1045.25 | 522.62 | 96.46 | <0.0001 |
| Shape | 2 | 6.81 | 3.40 | 0.63 | 0.53 |
| Tenderness | 2 | 8.43 | 4.21 | 0.78 | 0.46 |
| Price | 2 | 5.13 | 2.56 | 0.47 | 0.62 |

P=0.05, N=63

According to the results (Table 2), degrees of milling attribute was significant ($p<0.05$) while shape, tenderness and price attributes were not significant ($p<0.05$). This indicates that, degree of milling is highly valued by the consumers when they purchase rice. Further, interaction effects were not significant at 95% confidence interval.

According to the results (Table 3), “Brown” and “fully polished” levels were significant while none of the rest of the attribute levels were significant. Consumers have negative preference over brown rice and positive preference for fully polished rice. Once a consumer purchases one unit of brown rice in his consumer basket, the utility is decreased by 1.74 units. On the contrary, fully-polished rice is placed in the market basket his utility is increased by 1.62 units.

Table 3: Part-worth estimates of levels in quality attributes

| Attribute | Level | Estimate | Z value | P>Z |
|---|---|---|---|---|
| Degree of milling | Brown | -1.74 | -12.77 | 0.000 |
| | Partially-polished | 0.12 | 1.13 | 0.260 |
| | Fully-polished | 1.62 | 11.64 | 0.000 |
| Shape | Short-Round | 0.06 | 0.56 | 0.577 |
| | Long-Bold | -0.01 | -0.14 | 0.888 |
| | Long-Slender | -0.04 | -0.42 | 0.577 |
| Tenderness | Soft | -0.13 | -1.25 | 0.211 |
| | Medium | 0.05 | 0.51 | 0.608 |
| | Hard | 0.08 | 0.74 | 0.211 |
| Price | < Rs.60/kg | 0.05 | 0.46 | 0.648 |
| | Rs.60-70/kg | 0.07 | 0.63 | 0.526 |
| | > Rs.70/kg | -0.02 | -1.09 | 0.526 |

Pseudo $R^2$ = 0.0918. P=0.05, N=66

**Relative Importance of Attributes**

Table 4: Relative Importance of each attribute

| Attribute | Utility Range | Relative Importance (%) |
|---|---|---|
| Degree of Milling | 3.354 | 89.3 |
| Shape | 0.102 | 2.7 |
| Tenderness | 0.206 | 5.4 |
| Price | 0.094 | 2.4 |

The most important attribute among the selected, is degree of milling. Consumers do not pay much attention on other quality attributes of rice: shape, tenderness, and price in this particular consumer segment.

**Conclusions**

The study revealed that, degree of milling is the most important factor while the shape, tenderness and price of rice were not significantly affecting consumer choice in this market segment. Since this consumer segment is from urban profile, consumer choice has become price insensitive. They pay more attention over rice processing in making a purchasing decision. Consumers have negative preference for brown rice and positive preference for fully polished rice. Although, shape of the grain, tenderness of cooked rice, and price attributes were not significant, testing the same with different consumer segments while incorporating differently selected attributes may shed lights on estimating consumer preference more coherently.

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# Determination of microbial quality and quantity of stored cinnamon quills

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## Introduction

Since Cinnamon is one of the major spicecrops in Sri Lanka, maintenance of the quality of the processed cinnamon is very important. Microbial infection of processed cinnamon quills makes lowquality final product leading the product less demandedand high post-harvest losses. The prevailing solution for the microbial infection is fumigation of sulfur and it is not acceptable in many countries due to its harmful effects for consumer health. Therefore identification of common types of microbes on quills and determination offavourable conditions for microbial growth is very important to apply effective control measures.

## Methodology

Experiments were conducted to identify the particular types of fungi that thrive on cinnamon quills and the effect of moisture content, relative humidity, temperature and the storage period to the microbial growth. Cinnamon quills were collected from three different placesjust after processing. The moisture contents of the samples were measured in three days interval using gravimetricmethod. Average relative humidity and ambient temperature were also recorded each period. In quantification process, the number of colony forming units of fungi and bacteria in cinnamon quills were counted separately using colony counter.1g of powdered sample of cinnamon was dissolved in 10ml of distilled sterilized water and 200µl of the solution was poured in to the culture plates. It was allowed to incubate under the room temperature for about three days and colony count of fungi and bacteria were taken.The culture plates with microbial colonies were allowed to incubate further to obtain pure cultures of fungi by frequent sub culturing. Colony characteristics were observed with the time.The pure cultures of fungi were used to prepare slide cultures for microscopic identification highlighting the distinguishing characteristics (Funder, 1953; Cappuccino and Sherman 1996).

## Results and Discussion

According to the morphological and microscopic observations, *Rhizopus sp.*, *Penicillium sp.*, *Aspergillus niger*, *Aspergillus flavus* were the most common types of fungi encountered on cinnamon quills. In addition to those types *Trichoderma sp.* was appeared in the samples taken from one farmer place. It may be happened when peeled cinnamon had been kept in ground for drying and due to bad sanitary conditions in processing place.

*Rhizopus* sp. was rapidly growing white coloured fungus with cottony and fuzzy aerial mycelium. The color of the colony was white initially and turned grey to yellowish brown with time. It was grown as filamentous, branching coenocytichypha without cross-walls. Sporangia were developed on the long stalks raised as groups from nodes directly above the rhizoids. Unicellular ovoid, hyaline and striated sporangiospores were produced by *Rhizopus* species and they were grown as root like rhizoids initiallyand finally grown as large mycelium. *Penicillium* colonies were initially appeared in white colourand become blue green, gray green and then gray in colour respectively. It was grown as a thallus with typical characteristic of a highly branched network of multinucleate, septate, and usually colorless.Many-branched conidia sprout on the mycelia, bearing individually constricted conidiospores. *Aspergillus flavus* colonies were initially appeared in yellowish whitecolour and changed to olive green, dark green and brownish green respectively.Hyphae grew as a thread-like structure and they were septate and hyaline. The asexual spores,conidispores, produced in conidia were rough and dark.*Aspergillus niger* colonies were initially white and become brownish with white reverse and brownish black colour respectively covering the entire plate.Morphology of *Aspergillus niger* showed large, globose, dark brown conidial heads, which become radiate. Conidiophores are smooth-walled, hyaline or turning dark towards the vesicle. Conidial heads are biseriatewith the phialides, often septate. Conidia are globose, dark brown and rough-walled.*Trichoderma* colonies were wooly and the initialcolor is white. As the conidia are formed, yellow-green patches become visible making concentric rings.Conidiosphores were erect, smooth and penicillately branched. Globose conidia were developed on philides produced in the opposite direction in each point.

At the beginning the fungal infections of stored cinnamon were very low due to lack of enough inoculums, even though preferable higher moisture contents for fungal growth were retained in stored cinnamon quills. Next 10 days rapid increments of fungal colony forming units were observed because preferable moisture contents were retained further in cinnamon quills. Fungal infection was increased at 10 to 20 days also, but in negative rate due to desirable moisture contents were still remained in the cinnamon quills. Moisture content in the cinnamon quills were below 20 % after 20 to 30 days after processing and in this period fungal contaminations were gradually declined. When the moisture content was reached below 12% in storage cinnamon, fungal infection was at a minimum level. If the moisture level is reduced to below 12% in storage cinnamon as soon as possible, fungal infection can be controlled efficiently.

The most interesting phenomenon was the symbiotic relationship between fungal growth and bacterial growth (Figure1).There was very strong significant positive correlation between fungal and bacterial infections ($r = 0.912$, $p = 0.0001$). Bacterial contamination never had been occurred without fungal infection. Bacterial colonies were appeared in the culture plates used to have the fungal colonies separately, even though those were treated with antibiotics to retard the bacterial growth.When fungal infection is terminated by managing moisture content, the bacterial infection **is** automatically reduced (Figure 2).

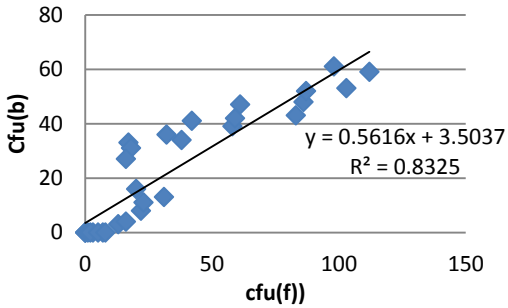


Figure 1. Relationship between number of fungal colony forming units [cfu(f)] and bacterial colony forming units [cfu(b)] during the period of storagein cinnamon

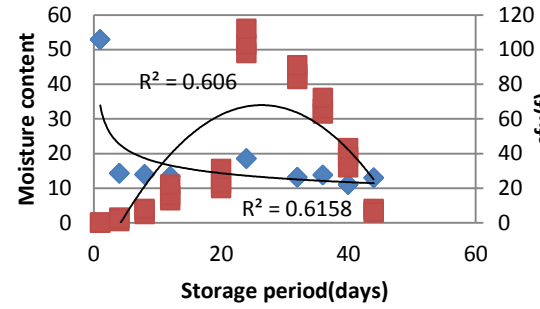


Figure 2. Relationship of moisture content and Fungal colony forming units during the period of storage

The number of fungal and bacterial colonies has been increased with the increment of relative humidity. These relationships were stronger in sample collected from processing center and farmer's place1 than farmer's place 2. Cultivated cinnamon was not belonging to individual variety and some cinnamon plants may have more resistance to microbial contaminants. Furthermore, fungal growth had stronger correlation with relative humidity than bacterial growth. In general, fungi and bacteria both were well grown and the spread in high relative humidity levels and it provided more favorable conditions for microbes' development in stored cinnamon.

The number of fungal and bacterial colony forming units makes a moderate negative relationship with temperature. Maximum number of fungal and bacterial colonies can be observed within the temperature range of 28 to 31$^0$C and the most favorable temperature range for post-harvest microbes on cinnamon quills may be 28 to 31$^0$C. This experiment was conducted Matara and the fluctuation of temperature was very low. Daily temperature was retained at 28 to 31$^0$C mostly during the study period and this range of temperature was optimum to growth of fungus in stored cinnamon. High temperature (35 $^0$C) with low relative humidity (20 %) and low temperature (20 $^0$C) with low relative humidity (10%) are the most suitable conditions for keeping insects and microbial contaminants away from stored cinnamon quills (Jayasinghe, 2012). Ambient temperature alone not affected microbial growth in stored products. When it is unified with other factors such as RH, moisture content, it will play major role to increase or decrease the microbial contaminants in stored cinnamon. In other hands, microbial contaminants attract the invertebrates concurrently such as frugivorous mites when the cinnamon is contaminated with fungus making the quality of the cinnamon quills lower furthermore.

**Conclusion**

Rhizopus sp., Penicillium sp., Aspergillus niger, Aspergillus flavus were the most common types of fungi encountered on cinnamon quills. The most favourable conditions for microbial growth was 80% to 90% of relative humidity, 28 to 310C of temperature, moisture levels above 20% and 20 to 30 days of storage period.

**Acknowledgement**

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# Development of ready to serve drink from gotukola (*Centella asiatica)*

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## Introduction

Gotukola (*Centellaasiatica*) is one of the valuable medicinal herbs and it has several food and beverage applications in many countries of the world. It is used by Sri Lankan people mainly as a leafy vegetable. *C. asiatica* is a good source of antioxidants and famous for its neuroprotective effect (Hashim, 2011). In addition, this herb is also used for treating in numerous kinds of diseases due to its rich phytochemical composition mainly asiaticoside, asiatic acid, madecassoside and madecassic acid (Tiwari et al., 2011). However, there is no any value added product in Sri Lankan market purely produced from Gotukola. Ready to serve drinks (RTS) are becoming popular recently in all over the world. This is an effort to develop leaf based ready to serve drink from Gotukola with acceptable quality standards. Creeping typeGotukola (HeenGotukola) was used for this study due to its nutritional value and to reduce its wastage by introducing a value added product.

## Materials and Methods

Current study was carried out at Food Research Unit, Gannoruwa, Peradeniya. Laboratory analysis was conducted at Laboratories of UvaWellassa University and laboratories of Veterinary Research Institute, Gannoruwa. Six preliminary trials were carried out to develop four different recipes by changing the percentage of leaf amount by mass as 5%, 7.5%, 10% and 12.5% with constant amount of other ingredients. First quality leaves were selected with stalk and washed properly. Leaves were dipped in Clorox (Sodium Hypochlorite / NaClO) added water for one minute. Then leaves were washed from pure water and leaf extract was separated after grinding. Leaf extract was mixed with prepared sugar syrup and heated up to 80˚C. Citric acid was added while preparing the sugar syrup. In each recipe quality standards of RTS drink like pH, brix and titratable acidity were tested according to SLS 729: 2010, to ensure whether product is fulfilled the quality requirements of RTS drink. Sensory evaluation was carried out using 5 point hedonic scale to select the best recipe from the developed four recipes. It was conducted for colour, taste, odour, mouth feel and overall acceptability using 25 semi trained panelists. Proximate analysis was carried out according to the method of AOAC for the product selected through sensory evaluation. Total polyphenol content was determined according to the method of ISO 14502 -1. Determination of yeast and mold, *Escherichia coli* and total plate count test were carried out under the microbial analysis of the final product. Shelf life evaluation for the final product was carried out for one month period under refrigerated storage conditions.

Total plate count test and sensory evaluation were conducted weakly as a part of that procedure. In addition to that, pH, brix and titratable acidity values were tested weakly.

**Result and Discussion**

Recipe with 7.5% of leaf amount by mass was selected as the best recipe from sensory evaluation. Percentage of polyphenol in the final product was 0.0712 mg / ml GAE.Proximate composition of the final product is shown in the Table 01. According to that, zero percentage of ash reveals the product is free from heavy metal contaminations. There is comparatively high amount of crude fiber than fat and crude protein.

Table 010: Proximate composition of the final product

| Parameter | Moisture | Ash | Crude protein | Fat | Crude fiber |
|---|---|---|---|---|---|
| Composition | 97.1% | 0% | 0.1% | 0.1% | 0.4% |

Brix, pH and percentage of tiratable acidity values of the final product are shown in the Table 02. According to that, both brix and pH values are inaccordance with the requirements for a RTS drink by Sri Lanka Standard Institute.Only percentage of titratable acidity is somewhat deviated from that. But pH value was mainly concerned in case of product safetythan percentage of titratable acidity and it was maintained at optimum level.

Table 02: Results of physicochemical properties of the final product

| Test | Mean Value |
|---|---|
| pH | 3.8 |
| Brix | 12.5 |
| Titratable acidity (%) | 0.5 |

According to the Table 03, yeast, mold and *Escherichia coli* in the final product are zero in 1 mL of the product. It is complied with the microbiological limits for a RTS drink by Sri Lanka Standard (SLS). Therefore product is safe for consumption.

Table 03: Results of microbial tests

| Test | Colony Count |
|---|---|
| Yeast and mold test | 0 CFU / 1 mL |
| *Escherichia coli* | 0 CFU / 1 mL |

Shelf life evaluation of the final product was conducted for one month period by evaluating the change in physicochemical properties and microbiological changes.Results of change in physicochemical properties are shown in Table 04. According to that, pH value has increased gradually during the first three weeks. In the fourth week there is a slight increase and fifth week there is no change in pH value. In order to prevent the microbial growth in the product, pH value should be lower than 4.2. That requirement for a RTS drink has not violated according to the pH values of the product during the one month period.Therefore product is microbiologically safe for consumption. A gradual decrease can be seen in percentage of titratable acidity of the final product. Brix value has not changed for first two weeks. It has increased gradually during last three weeks of the month. But the change in brix value has occurred within the acceptable range (12-16) according to the requirements of Sri Lanka Standard (SLS) for a RTS drink.

Table 04: Change in physicochemical properties of the product under shelf life evaluation

| | Physicochemical properties | | |
|---|---|---|---|
| Days | pH | Brix | Titratable acidity (%) |
| 0 | 3.7 | 12 | 0.52 |
| 7 | 3.8 | 12 | 0.48 |
| 14 | 4 | 12.3 | 0.41 |
| 21 | 4.1 | 13 | 0.36 |
| 28 | 4.1 | 13.6 | 0.34 |

Results of total plate count test conducted for three weeks under shelf life evaluation are shown in Table 05. According to that,there is a gradual increase in total plate count for three weeks. But that change complied with the requirements of Sri Lanka Standard (SLS) of total plate count (TPC) for RTS drink (Less than 50 in 1 mL of the product).Therefore product is safe for consumption.

Table 05: Change in total plate count of final product for three weeks

| Days | Mean plate count (CFU) |
|---|---|
| 7 | $9 \times 10^3$ |
| 14 | $18 \times 10^3$ |
| 21 | $28 \times 10^3$ |

## Conclusions

Product can be introduced to the consumers as a healthy leaf based beverage purely produced from Gotukola comprised with polyphenols. All the tested physicochemical and microbial parameters are fulfilled the requirements of Sri Lanka Standard (SLS) for RTS drink and therefore safe for consumption. According to the conducted shelf life evaluation,product has a one month shelf life.This is a good solution to reduce the wastage of "HeenGotukola" and to add value for this herb.

## Acknowledgement

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# Satisfaction of Low Country vegetable farmers about the agricultural extension service in Sri Lanka

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## Introduction

In Sri Lanka public sector organizations are the major party of extension delivery. The agricultural extension service in Sri Lanka was a greater service offering to all type of the farmers equally, irrespective of scale of farming. This service was started with the establishment of Department of Agriculture (DOA). The service was given by the DOA, agricultural research institutions and other agricultural related institutions in the state sector as public commodity. But this has reached to the critical stage. Large sum of public funds need to maintain and conduct the service. Due to the shortage of funds, government has to continue this service under big pressure. In this situation, due to lack of efficiency, effectiveness and not devoting sufficiently to the agriculture development of country government extension services are criticized as wasting public money (Mahaliyanarachchi, 2002)

This study was completed to find the satisfaction of low- country vegetable farmers on agriculture extension service in Sri Lanka. Objectives of the study were to determine satisfaction of farmers about the extension services, investigate factors which affect the satisfaction of farmers and find out extension needs of low- country vegetable farmers.

## Materials and methodology

This study was conducted in Anuradhapura and Monaragala districts where high productions of low- country vegetables are taken place throughout the year. Sample size was 200 farmers. Data were gathered using semi structured questionnaire. Semi- structured questionnaire was consisted to sought information on demographic characteristics of farmer (age, gender, education level, marital status etc.), information related farm (land extent, type of labour *etc*), information related to the extension service (frequency of the visit by the extension agent, methods of extension, teaching skills of the agent, communication skills of the agent and satisfaction of the farmers etc.)

Independent variables which were used to test hypotheses were subjected to judge by the respondents. The statement on a 5 point Likert scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) Strongly Disagree (SA) and scores of 5, 4,3,2,1 were assigned to the corresponding responses for positive statement and the reversed scores for the negative statements. Using the minimum score of (1) and maximum score of (5): Dependent variable was Satisfaction of farmers: Satisfaction is the dependent variable which was inquired from the respondents directly. Farmers were asked to mention overall satisfaction about extension service. (1) Satisfied (2) Not Satisfied.

Data collection was done by the researcher. Personal interview was used to collect data according to the semi structured questionnaire. Sampled farmers of two districts were interviewed through field survey. Collected data were arranged, coded and analyzed through the use of Statistical Package for the Social Sciences (SPSS) computer programme. Both descriptive

and inferential statistical tools were used to analyze the data.Descriptive statistical tools used were frequency counts, percentages and mean.Inferential statistical tool was used to test the hypotheses of the study.Chi-squire test was used to measure the significant relationship between independent variables in the model and dependent variable in the model.

Logistic Regression Analysis used to test amount of variability of the dependent variables that could be explained by the independent variables. The regression coefficients identified and estimated how variable input included in the model best explained the variability on output.

The model is:

Log (p)= $\beta$0+ $\beta$1 X1+$\beta$2 X2+ $\beta$3X 3+$\beta$4 X 4 +$\beta$5X5+ $\beta$6X6+$\beta$7X7, $\beta$8X8, ...$\beta$12X 12

Log (p) – probability of being satisfied or not

$\beta$1…….$\beta$12 – Coefficients

$\beta$0 - Constant

X1- Extension source 1

X2- Frequency of visit

X3- Appropriateness of Extension method

X4- Perceived Qualifications of extension Agent

X5- Perceived practical knowledge of extension agent

X6- Adequate information delivery

X7- Timely information delivery

X8- Trustworthiness of extension agent

X9- Peer presence for decision making

X10- Continuity of extension service

X11- fairness of extension service

X12- Dealer presence for decision making.

**Results and Discussion**

Demographic characteristics of farmers

Majority (42% of total sample) of farmers is more than 50 years and 78% of farmers are male respondents. According to the findings only 5% of the farmers are single where 95% of the farmers are belongs to the married group. Highestproportion (48% of the total sample) of the respondents is able to get secondary education. Only 26% of the total sample is in no formal education group. 67.5% of the total sample is highest proportion in experience more than 15 years. Majority of the farmers are engaged in farming in full time. Approximately 84% farmers are members of any kind of agricultural organization. Approximately 35.5% of the sample of farmers has 1.5- 2.5 acres of land extent. Most of the farmers use family labours for their farming activities. According to the results own land percentage is 82.5% and other land percentage is 17.5%.

Extension Source Related Characteristics

Highest proportion (57%) of the farmers is get information from government extension source only. Nearly 30.5% of farmers useonly their own experience for cultivation. Approximately 4.5% of farmers areget information from both government and private input supply companies while 3.5% of farmers are get information only from private input supply company. And also 3% of farmers areget information from both government and non-government organizations. Only 1.5% of farmers are get information from non- government organization.Nearly 60% of farmers are experienced no visits by extension agents of their fields. Nearly 19.5% of farmers are able to get extension agent's visit when farmers required. Approximately 10% of total farmers arevisited by the extensionagent once per month while 5.5% of the farmers are visited by the extension agent twice per month. Only 5% of the farmers are experienced extension agent's contact thrice per month. Most (57%) of the farmers are required information regarding pest and diseases only. All information is needed by the 39.5% of total sample while agronomic practices and irrigation information required by 1% of total farmers and selection of crops for cultivation are required by 0.5% of total farmers. Most of the farmers use new hybrid varieties for their cultivation..

Social Behavior of Farmers

Approximately 45.5% of total farmers were strongly agreed that they rely on peer farmer's decision. Nearly 32% of farmers were agreed that they considered peer farmers as good decision body. Only 17% of farmers were disagreed about above condition while 3% and 5% of farmers had no idea and strongly disagreement accordingly.According to the data 20% of farmers were agreed that dealer was considerable decision making body for their cultivation. Approximately 14% of farmers were strongly agreed about above condition. Nearly 10% of farmers had no idea. Majority of farmers were disagreed. It was approximately 50%. Nearly 6% of farmers were strongly disagreed about above statement.

Satisfaction of Farmers on Agricultural extension sources

Most of the farmers were not satisfied about the extension sources. It was about 66.5%. Minority of farmers were satisfied about the extension sources. It was nearly 33.5%.According to the chi-squire test Extension source, frequency of visit by extension agent, appropriateness of extension methods, perceived qualification of extension agent, perceived practical knowledge of extension agent, adequate information delivery, timely information delivery, trustworthiness of extension agent, peer presence for decision making, continuity of extension agent, fairness of extension service, buyer presence for decision making variables were significant at 95% confident interval. From above variables Binary Regression was run.

Binary Regression Model yielded following results.

According to the model summery pseudo $R^2$ is 62.9% and 87.2%. -2 Log likelihood also smaller and near to zero. Therefore goodness of model is in considerable level.

Table 01: Variables in the Equation

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | EX.SOURCE * | .659 | .296 | 4.967 | 1 | .026 | 1.933 |
| | VISIT | -.171 | .271 | .400 | 1 | .527 | .843 |
| | METH | -.969 | .657 | 2.177 | 1 | .140 | .380 |
| | QUALI * | 1.705 | .591 | 8.325 | 1 | .004 | 5.499 |
| | PRAC | -.400 | .386 | 1.070 | 1 | .301 | .670 |
| | ADQINF | -.298 | .579 | .266 | 1 | .606 | .742 |
| | TIMINF * | 1.296 | .459 | 7.957 | 1 | .005 | 3.655 |
| | TRUST * | 3.264 | .865 | 14.231 | 1 | .000 | 26.165 |
| | PEER | .513 | .313 | 2.676 | 1 | .102 | 1.670 |
| | DEALER | -.597 | .339 | 3.092 | 1 | .079 | .551 |
| | CONTIN * | .972 | .359 | 7.337 | 1 | .007 | 2.644 |
| | FAIR | .383 | .359 | 1.140 | 1 | .286 | 1.467 |
| | Constant | -20.884 | 4.662 | 20.065 | 1 | .000 | .000 |
| Variable(s) entered on step 1: EX.SOURCE, VISIT, METH, QUALI, PRAC, ADQINF, TIMINF, TRUST, PEER, DEALER, CONTIN, FAIR. Significant at 0.05- * | | | | | | | |

Under 95% confident intervals

According to the results Extension source is significantly affect to the satisfaction of farmers about the extension source. Sig. is 0.026. Coefficient of perceived qualification of extension agent is + 0.659. It explains positive relationship with satisfied farmers and extension source. Frequency of visit by extension agent and Appropriateness of extension methodsis not significantly affect to the satisfaction of farmers about extension sources. The sig. values are in accordingly 0.527 and 0.140. Both of values are higher than p value. (0.05). It shows there is no relationship between Appropriateness of extension methods and satisfied farmers.

Perceived qualification of extension agent is significantly affect to the satisfaction of farmers about extension services since the sig. is 0.004. Coefficient of extension source is +1.705. It explains the positive relationship with satisfied farmers and perceived qualification of extension agent. It shows tendency of farmers to be satisfied about extension services when extension agents are with perceived educational qualifications.Above results highlighted Practical Knowledge of extension agent and adequate information delivery by the extension agent is not significantly affect to the satisfaction of farmers about the extension sources. The sig. values are 0.301 and 0.606 in accordingly.

According to the results timely information delivery by the extension agent is significantly affect to the satisfaction of farmers about the extension services. Sig.is 0.005. Coefficient of extension source is 1.296. It explains the positive relationship with satisfied farmers and timely information delivery by extension agent. It shows tendency of farmers be satisfied about extension services when extension agents are deliver timely information to the farmers.Trustworthiness of extension agent is significantly affecting to the satisfaction of farmers about the extension services. Sig is 0.000. Coefficient of extension source is 3.264. It explains the positive relationship with satisfied farmers and trustworthiness of extension agent. It shows the tendency of the farmers to be satisfied about the extension services when extension agents are trustworthy.

Peer presence for decision making, Dealer presence for decision making and Fairness of extension service is not significantly affect to the satisfaction of farmers about the extension services. Sig Values are accordingly 0.102, 0.079 and 0.286. Continuity of extension service is significantly affected to the satisfaction of farmers about the extension services. Sig is 0.007.

Coefficient of continuity of extension service is 0.972. It explains the positive relationship with satisfied farmers and continuity of service. It shows tendency of farmers to be satisfied about extension services when extension agents are increase continuity of service.

Equation

Logit(Satisfaction) = -20.884 + 0.659(Extension source) + 1.705(Perceived qualification) + 1.296(Timely information delivery) + 3.264(Trustworthiness of agent) + 0.972(continuity of service)

**Conclusion**

Majority of low country vegetable farmers are not satisfiedabout agricultural extension services in Sri Lanka. According to the finding of the study, Timeliness of information, trustworthiness of extension agent, perceived qualification of extension agent, extension source and continuity of extension source are the variables which are significantly affect to the satisfaction of extension service.

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# Nitrogen and potassium fertilizer response on growth and yield of hybrid Luffa –Naga f1 variety

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## Introduction

Luffa is a tropical and subtropical vegetable, belongs to family Cucurbiteceae. It is predominantly monoecious in sex expression and provides an ample scope for utilization of hybrid vigor. Hybrid varieties develop through open pollination, produce higher yields due to its hybrid vigor. Naga F1 hybrid variety consists number of desirable traits other than higher yield such as strong and vigorous plants, fruits with long deep ridges, attractive green color fruits ,better fruit weight, length and early maturity compared to the local Luffa cultivars.Unavailability of fertilizer recommendations for hybrid cucurbit vegetables leads to an excess fertilizer application causing a vital environmental issue that creates undesirable impacts on nature and the human health.

Main Objective of this research is to determine effect of different nitrogen and potassium fertilizer rates on growth and yield of Naga F1 Variety. Other objectives are, to evaluate specific growth parameters and yield, to identify the optimum nitrogen and potassium fertilizer levels based on growth and yield of hybrid Luffa variety. As well as to formulate the general fertilizer recommendation for hybrid Luffa -Naga F1 variety.

## Methodology

Hybrid Luffa - Naga F1 variety seeds were used as planting material. The experiment consisted of nine treatments involving three nitrogen fertilizer levels and three potassium fertilizer levels based on recommendation of the Department of Agriculture for local Luffa varieties. Recommended dosage of phosphorous fertilizer level was applied for each treatment.Fertilizers were applied at the basal dressing and two top dressings in three week intervals accordingly. Fertilizer sources for N, K and P are Urea, Muriate of Potash (MOP) and Triple Super Phosphate (TSP) respectively. The study was carried out in randomized complete block design.

Field experiment was conducted in order to obtain growth and yield parameters of Naga F 1 variety. Plant growth parameters were leaf number per vine and vine length at 1st, 2nd and 3rd weeks after planting intervals. Yield attributes were fruit girth, fruit length, yield per vine, yield per hectare up to ten consequent harvest. Laboratory analysis were performed in order to determine initial soil composition andnitrogen and potassium contents in leaves and fruitsat peak harvesting stage. Data were analyzed using Minitab 17 statistical software. Treatment means differences were evaluated by Tukey mean comparison tests at 0.05 significant level.

**Results and Discussion**

According to growth performances, significantly (P<0.05) highest mean vine length (14.8, 62.3, 118.7) was observed with T5 at 1WAP, 2WAP and 3WAP intervals respectively. T5 consisted with 75% (56.25Kg/ha) urea and 75% (45Kg/ha) muriate of potash fertilizer levels. Researches has proven slightly contrasting results regarding nitrogen fertilizer application rates in cucurbits. Das et al. (1987) observed significant increase in length of vine with the application of 90 kg nitrogen per ha compared to lower doses (0, 30 and 60 kg ha-1) of nitrogenin pointed gourd.

Table 01: Effect of N and K fertilizer levels on vine length

| | Mean Vine Length (cm) | | |
|---|---|---|---|
| Treatment | 1WAP | 2WAP | 3WAP |
| T1 N (0%) K (0%) | $14.0^{bc}$ | $57.2^{b}$ | $83.3^{g}$ |
| T2 N (75%) K (0%) | $12.9^{d}$ | $57.2^{b}$ | $106.0^{bc}$ |
| T3 N (150%) K (0%) | $14.2^{ab}$ | $39.6^{g}$ | $93.2^{ef}$ |
| T4 N (0%) K (75%) | $14.0^{bc}$ | $43.5^{e}$ | $96.7^{de}$ |
| T5 N (75%) K (75%) | $14.8^{a}$ | $62.3^{a}$ | $118.7^{a}$ |
| T6 N (150%) K (75%) | $14.5^{ab}$ | $48.3^{d}$ | $88.0^{fg}$ |
| T7 N (0%) K (150%) | $13.6^{c}$ | $43.6^{e}$ | $97.7^{cde}$ |
| T8 N (75%) K (150%) | $14.1^{bc}$ | $53.6^{c}$ | $103.4^{bcd}$ |
| T9 N (150%) K (150%) | $14.0^{bc}$ | $42.0^{f}$ | $111.3^{ab}$ |
| CV | 89.86 | 99.99 | 99.97 |

Values followed by the same letters are not significantly difference at $P \leq 0.05$

According to the yield performances exhibited in Table 02 , highest yield per ha (23.09 t) ) was recorded with the application of 150% (112Kg/ha) urea and 75%(45Kg/ha) muriate of potash fertilizer levels.Main effect of nitrogen fertilizer was significant ($P$<0.05) on yield per hectare.
This results were supported by Suresh and Papaiah (1991) that observed significantly higher fruit weight, number of fruits, fruit yield and fruit yield per ha with the application of 80 kg nitrogen per ha compared to lower doses of nitrogen (0 and 40 kg $ha^{-1}$) in bitter gourd.Umamaheswarappa*et al.* (2003) recorded increase in fruit yield with increased level of nitrogen in bottle gourd.

Table 02**:** Effect of N and K fertilizer levels on yield per ha

| Treatment | Yield per ha (t) |
|---|---|
| T1 N (0%) K (0%) | 12.26 [a] |
| T2 N (75%) K (0%) | 16.10 [a] |
| T3 N (150%) K (0%) | 17.59 [a] |
| T4 N (0%) K (75%) | 13.92 [a] |
| T5 N (75%) K (75%) | 21.36 [a] |
| T6 N (150% )K (75%) | 23.09 [a] |
| T7 N (0% ) K (150%) | 12.19 [a] |
| T8 N (75%) K (150%) | 21.64 [a] |
| T9 N (150%) K (150%) | 19.83 [a] |
| CV | 56.38 |

Values followed by the same letters are not significantly difference at $P \leq 0.05$

**Conclusions**

Naga F1 variety exhibited positive growth and yield responses at different nitrogen and potassium fertilizer levels in significant manner. At vegetative growth, better vine length was observed with the application of 75% (56.25 kg ha-1) urea and 75% (45 kg ha-1) muriate of Potash fertilizer combination level.According to the yield attributes, maximum yield per hectare was exhibited with the application of 150% (112 Kg/ha) urea and 75% (45 Kg/ha) muriate of potash fertilizer levels. A general fertilizer recommendation can be concluded as 150% (112 Kg/ha ) urea, 100% (65 Kg/ha ) triple super phosphate and 75% (45 Kg/ha )muriate of potashfor the selected Luffa hybrid - Naga F1 variety.

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# Patterns of fresh fruit consumption of households in Kurunegala

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## Introduction

Agriculture is the most common vocation of the Sri Lankan. Different varieties of fruits are cultivated in Sri Lanka's varied agro-climatic regions. Fruits play a major role in the well-being of consumers. Consumption of fruits contributes to an increase in the nutritional level of people. The food pyramid developed by the United States Department of Agriculture (USDA) recommends, 2-4 servings of fruits per day (Life clinic international, 2010). According to MRI the daily per capita requirement of fruits for a balanced diet should be 30-40 g (edible portion), which is approximately equivalent to 25-40 kg fresh fruit per head per year. However, Sri Lanka's per capita consumption of fruits and vegetables remains far below the required average daily intake (Ceylon Chamber of Commerce, 2010). In the process of enhancing fruit consumption, it is very useful to consider the needs, preferences and behavior of consumers. The main objective of this study is to find demand for different fruit types and the factors that influence households consuming of different fruit types.

## Methodology

A deductive research approach was followed. Survey strategy was used as a research strategy. Primary Data were collected through an interviewer administered questionnaires and most research questions had descriptive purposes. Before collecting data pilot test was used to identify the problems while responding to the questionnaires. Kurunegala District in North Western Province, was selected as the research area. It consists of 30 Divisional Secretariats, 1610 Grama Niladari Divisions and 4476 total Villages (Department of Census and Statistics, 2009). Kurunegala district has 412,897 households (District Statistical Branch, Kurunegala). The sample size was about 153 households which are from Kurunegala District. The stratified random sampling technique was used as sampling method to select households Types of fresh fruit consumption among different households and consumption frequency of different fruit types were analyzed by descriptive analysis. Chi-square Test was the statistical analytical tool applied in identification of consumption pattern of across various household groups. Microsoft Excel and Minitab 14.0 Software programs were used to analyze the data.

## Results and Discussion

Results reveal that there is no significant difference between three types of locality groups (urban, semi urban and rural) when they are consuming fruits. But rural residents had low expenditure on fruits compared to the urban and semi-urban resident, due to varieties of local fruit available in their home garden. Banana, papaw, mangoes and pineapple are the major fruits consumed in the Kurunegala District. The majority of the respondent did not intake fruit as daily consuming food. In Household fruit consumption, those who do not consume fruits daily, consume fruits around 3-4 days per week. In the study household banana consumption was 3 days per week while papaya, mango, and pineapple are consumed 2-3 days in a week. According

to the food pyramid developed by USDA, Kurunegala district household's fruit consumption is lower.

**Relationship between Social, Economic Characteristics and Fruit consumption**

Studies prove that age, gender, household size, income, occupation, education level, marital status significantly affects household fruit consumption (Whichelow and Prevost, 1996; Mirmiran *et al.*, 2009; Billson, 1999). The data were in line with previous findings from the USDA, that the major factors affecting fruits consumptions were income, age and education of consumers (Biing, 2004). Table 01, shows there are significant relationships between marital status, occupation, education level, income with household fruit consumption at the 0.05 significance level. At the same time, there were no significant relationship between gender, household size and age towards household fruit consumption at the 0.05 significance level. Therefore, in this study, household income, occupation, marital status, and education level have a significant relationship with household fruit consumption and age, household size and gender did not significantly affect the household fruit consumption.

Table 1: The Association between Socio Economic Characteristics and Fruit consumption

| Factor | Chi Square value | D F | P value |
|---|---|---|---|
| Marital Status | 99.000 | 9 | 0.000* |
| Occupation | 10.763 | 4 | 0.029* |
| Education level | 148.665 | 4 | 0.000* |
| Income | 18.416 | 4 | 0.001* |
| Gender | 7.307 | 4 | 0.121 |
| Household size | 7.169 | 4 | 0.127 |
| Age | 8.939 | 6 | 0.177 |

* Significant at 0.05 significance Level

Considering the preference to consume fruits, according to the gender, males consume same amounts of fruit as females. Age also seem to be indifferent in fruit consumption in households. Children, young, middle age, and adult group have the same preference to consume the fruits.

The study proves income has a significant effect on household fruit consumption. Besides the financial aspect just indicated – higher education generally means higher income. This could be correlated with greater knowledge and awareness of healthy eating habits in those households with higher education levels. The study also shows the marital status to have a significant effect on household fruit consumption at the 0.05 significance level. Being married positively impacts on the amounts of fruit consumed due to the Women seem to have a positive influence on their family intake, frequency, amounts and variety of the fruit eaten.

**Social environment and Personal factors affecting to fruit consumption.**

Availability of and access to fruit in the home garden is important for consumption of fruit. Similarly, the availability of and access to fruit and vegetables in the home is important for consumers in both children and adults. Also, concerning of fruit has high nutritional value, fruit can be taken as fast fruit and taste of different type of fruit, household member encourage them to eat fruit had an impact on their fruit consumption.

**Conclusion**

Banana, papaw, mangoes and pineapple are the major fruits consumed in the Kurunegala District. In Kurunegala district, Household fresh fruit consumption is averagely five to six fruit species per 3-4 days a week. Results showed that fruit servings per week have a significant relationship with education, monthly income, marital status, and occupation. Gender, Household size and age do not significantly affect the consumption of fruit. Marital status seems to play a significant role in the consumption of fruit. Being married is associated with increased fruit intake while being single/ divorced/ separated is associated with lower levels of fruit consumption. Low-income households spend less than higher income households on fruits. Therefore, understanding the consumption difference between income groups is important for targeting interventions for healthy eating. However, high costs may negatively impact on fruit intake levels. This does not only concern low income groups. Also, people with higher incomes perceive price as a barrier to consumption of these foods. Individual preferences, parental intake and home availability/accessibility towards fruit have an impact on consumption levels. The study proved Home gardens are a rich source of fruits, and have the potential of improving both intake and diversity of fruits in the diet.

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# Farmers perception on cultivating medicinal plants as an agribusiness venture: a study at Pambahinna agrarian services division

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**Abstract**

Medicinal plants have been used in Sri Lanka for many purposes since early civilization. Recently both national and international demand for ayrvedic medicinal materials has been increased due to increased health awareness. But unfortunately Sri Lankan cultivations presently do not at least provide for the demand for the country itself, this leads to import many plants from countries like India, Pakistan and Dubai. Therefore the propose of this research was to identify farmers perception on medicinal plant cultivation as an agribusiness which could be an important perspective to develop this sector. This research was particularly carried in Pambahinna Agrarian Services Division. In the research questions farmers experience and knowledge on medicinal plant, awareness on markets, potentials and constrains of this industry was discussed. A survey was conducted among randomly selected sample of 111 farmers within 10 GN (gramasewa niladari) divisions and obtain information through an interviewer administrated structured questionnaire. Data analyzing was done using mini tab 14 and MS Excel using descriptive statistics, graphical explanations, and *chi square* test. Concerning on awareness, many farmers were aware about the value of medicinal materials but they lack information about such agribusinesses so they lack motivation and inspiration
***Key words:*** Perception, Medicinal plants, Agribusiness

## Introduction

Common medicines like ginger, garlic, and coriander were used by ancient physicians and used by the people even today. In fact the chemicals used in western drugs were originally extracted from medicinal plants. There is a current trend evolving in many developed and developing countries to move back to old traditions in medicine and especially in beauty culture. The national demand for medicinal plant materials was 3,864,760 kg in 2000 and approximately 1,509,201 kg of this amount were imported to meet the national demand at a cost of about Rs. 13 million (Abeywardana, N and Hettiarachchi, J. K., 2001). Hence great potential exists to organize the cultivation medicinal plants on commercial scale to increase the domestic supply of raw materials (Joseph and Abeysekera, 2004; Gunasena *et al*., 2004). This paper looks at the farmers' willingness to cultivate medicinal plants as an agribusiness venture and to find out the potentials and constraints in medicinal plant cultivation.

## Objectives

### Broad objective

My broad objective is to find out farmer perception on planting medicinal plants as an agribusiness.

### Specific objectives

- To find out the level of experience and knowledge available within the farmer community on medicinal plant cultivation that would help them for easy adaptation process.
- To assess the level of farmer awareness on market demand, price and buyers of medicinal plants.
- To discover the potentials and constrains of this agribusiness in farmers point of view.
- To determine the farmers perception towards this business.

## Methodology

Research Design

- Research approach - Deductive research approach
- Type of the research - Descriptive
- Research strategy - Survey strategy

Target Population

- Target population was farmers in ten GN divisions in Pambahinna agrarian services division

Sampling Technique

- Systemic sampling

## 4. Results and Discussion 4.1 Demographic factors of farmers

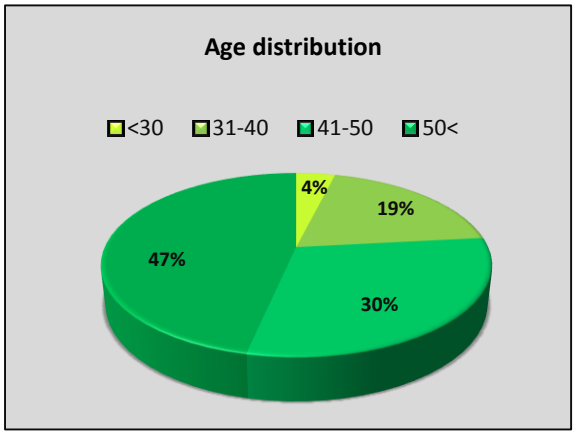


**Figure 4.1: Percentage of farmers based on age**

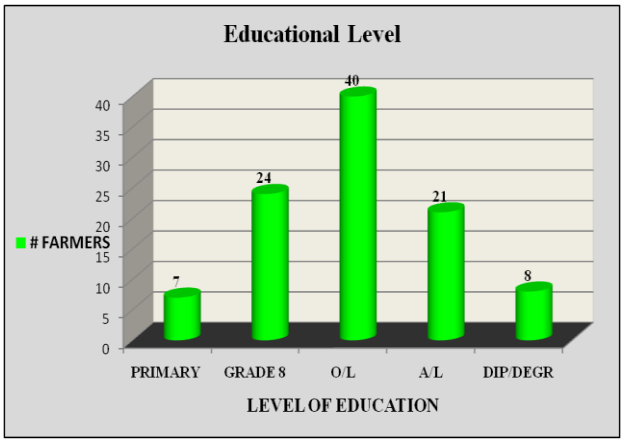


**Figure 4.2: Education level of farmers**

**Objective 1: Experience and knowledge available within the farmer community on medicinal plant cultivation**

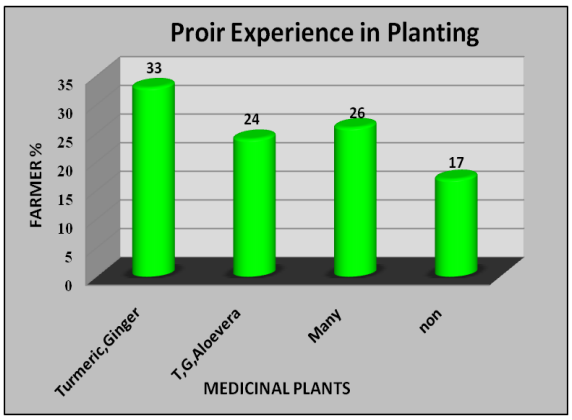


**Figure 4.3: Prior experience in planting**

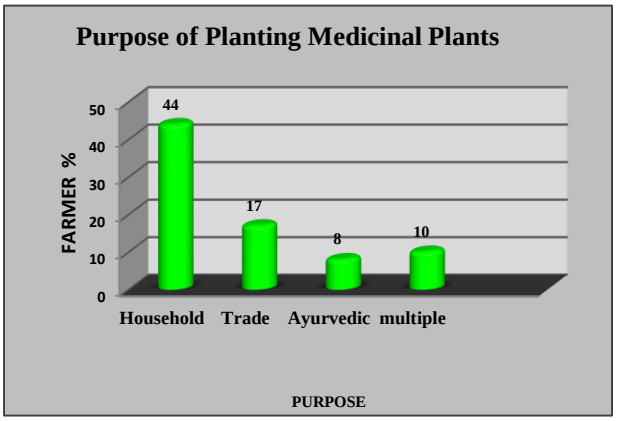


**Figure 4.4: Purpose of planting herbal**

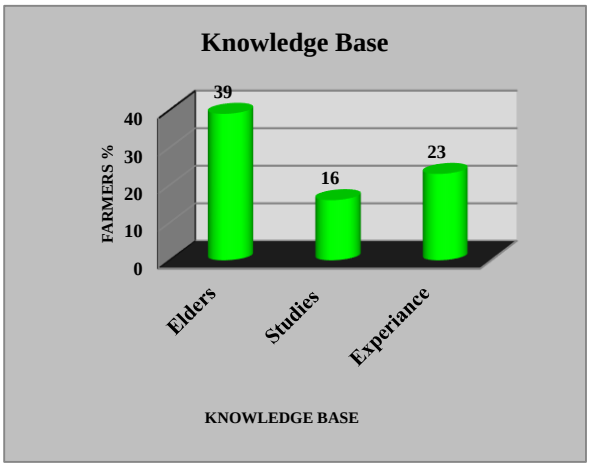


**Figure 4.5: Knowledge base**

**Table 3**: Factors effecting experience and knowledge

| Factor | Chi square | D.F | P. Value |
|---|---|---|---|
| Age | 29.221 | 1 | 0.000 |
| Farming experience | 12.936 | 6 | 0.008 |
| Gender | 11.851 | 3 | 0.044 |
| Level of education | 10.263 | 6 | 0.114 |

4.2.2 Relationship between factors effecting experience and knowledge on medicinal plant cultivation

**$H_0$**: There is no relationship between following demographic variables and experience and knowledge on medicinal plant cultivation.

**Objective 2: Farmer Awareness on Medicinal Plant Businesses and Its' Market.**

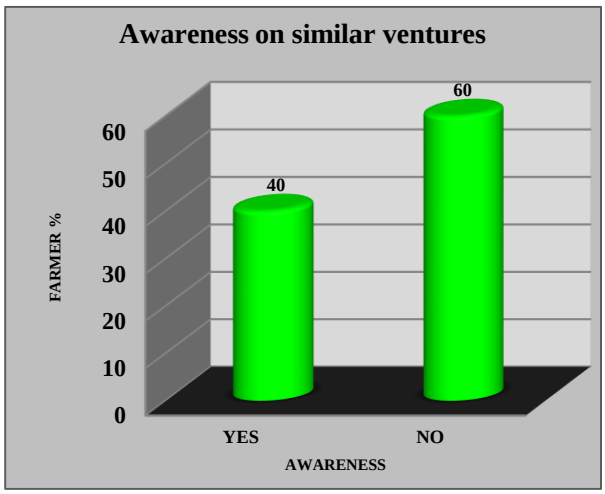


**Figure 4.5: Awareness on similar ventures**

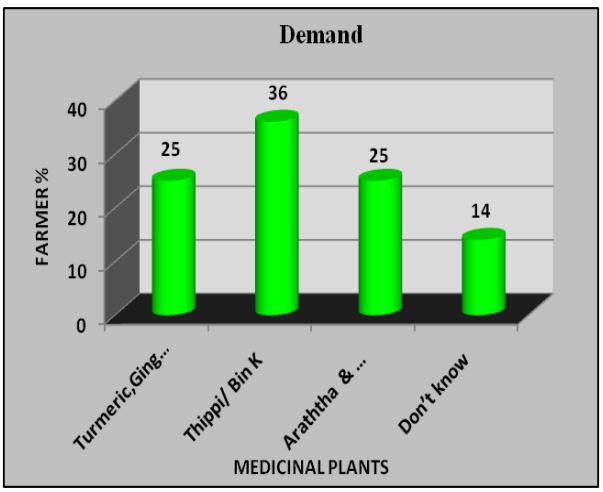


**Figure 4.6: Familiarity with demanded medicinal plants**

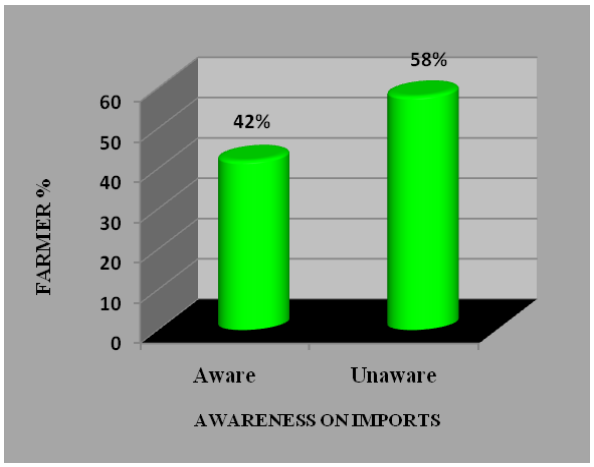


**Figure 4.6: Awareness on medicinal plant material importation.**

Objective 3: Potentials and Constrains of This Business in Farmers Point of View

Table 5: Reasons for the willingness to adopt

| Reasons | Mean | Mode | S D |
|---|---|---|---|
| Can find planting materials easily | 4.21 | 5 | 2.844 |
| This is high profit generating business | 1.746 | 1 | 2.496 |
| High plant vigor and easy to maintain | 5.25 | 4 | 2.08 |
| Supportive climatic condition | 2.713 | 3 | 1.853 |
| As a secondary source of income | 2.234 | 2 | 1.772 |

Table 6: Reasons for not to start this venture

| Reasons | Mean | Mode | S D |
|---|---|---|---|
| Land limitation | 1.246 | 1 | 1.573 |
| Demand uncertainty | 2.231 | 2 | 1.363 |
| Loopholes in value chain and theft | 2.385 | 3 | 1.387 |
| Hesitance to change from current business | 4.231 | 4 | 2.006 |
| Lack of knowledge on medicinal plants and their cultivation | 5.231 | 5 | 1.964 |

Objective 4. Farmer Attitudes in Practicing Medicinal Plant Cultivation as a New Business.

| STATEMENT | Disad. | Nura. | Agre.. | mode | mean | S.D |
|---|---|---|---|---|---|---|
| Medicinal plants are easy to maintain | 13 | 20 | 67 | 4 | 4.18 | 0.697 |
| There is a high demand for medicinal plants | 2 | 25 | 73 | 4 | 3.7 | 0.435 |
| This is a potentially profitable business | 13 | 38 | 49 | 4 | 3.39 | 0.704 |
| This business will be a good industry in future | 12 | 45 | 43 | 3 | 2.5 | 0697 |
| I would like to try this new venture | 14 | 25 | 58 | 4 | 3.46 | 0.736 |

## Conclusion

Majority of the farmers have enough capacity and will to engage in this business. If they are provided with a slight assurance on buyers, necessary information on the market. And if they are aware of the shortage of supply in national level, there could be a possibility of getting more farmers involved in medicinal plant cultivation as a venture or as an additional income source. Therefore, it is recommended from this study to create awareness on the potential of growing medicinal plants as a venture will encourage them to grow medicinal plants.

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