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Dheerpura Society for Advancement of Science and Rural Development
Branch Office : Bhopal (M.P.) 462 001, India

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RESEARCH PAPERS

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Study of Physical Properties of Garlic Plant for Garlic Harvester Design

PRIYANKA RAJKUMAR KHOLE AND K. K. JAIN

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Garlic (*Allium sativum* L.) is a bulbous crop from *Alliaceae* family, native to central Asia and has long been a staple in the Mediterranean region. It has been a frequent seasoning in Asia, Africa, and Europe. It is one of the important bulb crops. It is used as a spice or condiment through India. The compound bulb of garlic consists of several small cloves.

Though India is second largest producer of garlic, its productivity (5040 kg/ha) is low as compared to world average productivity of 14730 kg /ha (Anon., 2012b). There are many factors contributing to low productivity in India. In India, garlic harvesting is mostly done by hand picking, which is time consuming and labour-intensive. On an average, 300-350 man-h/ha are required for digging or pulling of garlic.

Besides the quantum of labour, manual harvesting involves considerable drudgery and human discomfort. The labour has to stoop forward while digging or pulling garlic plant from the bed and also during picking up. Stooping posture results physical stress in the back and has higher energy consumption as compared to other working positions. The labour engaged in harvesting has to squat to move to next harvesting position. Both stooping and squatting postures are not ergonomically desirable and, therefore, garlic harvesting operation involves considerable human drudgery. Continuous use of bare hands for pulling out garlic crop may cause bruises on hands leading to infection.

Manual harvesting is not only laborious and time consuming, but labour unavailability during the peak season of harvesting is also a major problem. At times, labour unavailability delays the harvest, which results in damage to crop.

The harvesting operation of garlic needs to be mechanized for time saving, reduced drudgery, improved field efficiency and reduced harvesting cost. In India, no such major work is reported on mechanical harvesting of garlic. For design of a garlic harvester, Physical properties

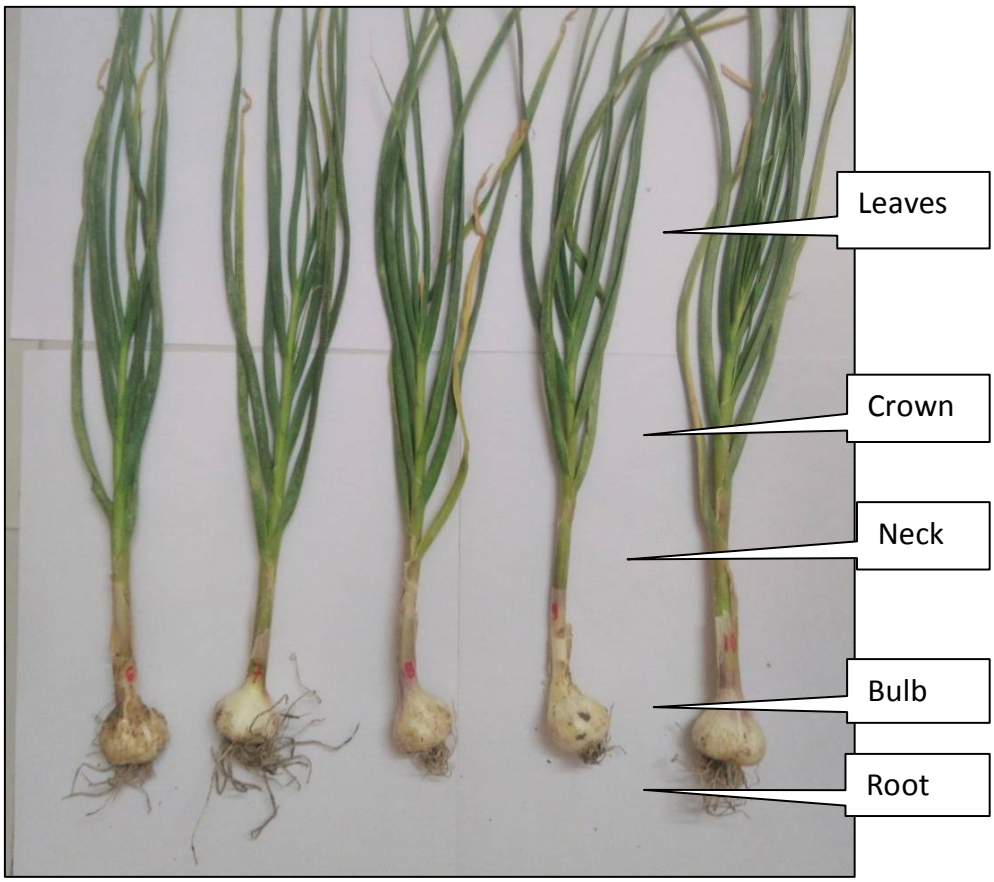

Fig. 1. Physiological parts of garlic plant

of garlic plant are important. These properties were measured at the harvesting stage of crop with the help of measuring scale and vernier caliper.

MATERIALS AND METHODS

Main objective of the study was to develop and evaluate the performance of mini tractor operated garlic harvester. Under this study, the (GJG-5) variety of garlic was studied. In the study the physical parameters of garlic crop were measured, in the field at the harvesting stage, on the standing garlic crop with the help of measuring scale and vernier calipers. The physiological construction of garlic bulb consists of a swelling in the leaves just above the point of attachment of the stem to the roots. The part of the leaves protruding from the garlic bulbs is referred to as the tops, the surface at which these top leaves are attached to the garlic bulb, is referred to as the crown, and the tops; immediately above the crown are referred to as the neck, Figure 1.

The observations were taken on the characteristic dimensions of the garlic plants and bulbs, which were relevant to the study. To determine position of bulb with respect to ground surface, the quantity of the material to be handled by the harvester for separation, and throat height of the harvester the following measurements were taken:

Table 1. Physical Properties of Garlic Plant

Sr. no.	Parameters
1.	Number of leaves per plant
2.	Length of garlic leaves
3.	Depth of garlic Bulb below the ground level
4.	Polar diameter of garlic bulb
5.	Equatorial diameter of garlic bulb
6.	Weight of plant
7.	Bulk density of garlic bulb

Physical properties of garlic plant like weight of plant, plant length, polar diameter and equatorial diameter of garlic bulb affects the design parameters of harvester. These properties influences design parameters as spacing between the rods of soil separator, material handling capacity of soil separator, etc. Physical properties of garlic plant are important for design of a garlic harvester. These properties were measured at the harvesting stage of crop with the help of measuring scale and vernier caliper.

Number of leaves per plant

Observations were made by counting number of matured and green leaves per plant on fifteen randomly selected plants of garlic. The maximum and minimum number of leaves was determined

Length of garlic leaves

The length of the leaves was used for designing the throat height of the harvester and length of the conveyor. Fifteen plants were selected randomly and their lengths were measured with a scale. The maximum, minimum and average length of leaves was determined.

Depth of garlic Bulb below the ground level

The depth of garlic bulb in soil is used to estimate the volume of soil to be handled by the harvester. Depth of bulb with respect to ground surface was observed for fifteen randomly selected garlic plants.

The measurement was done using scale and a flat plate. The flat plate was kept along the ground and the scale was inserted in soil up to the bottom of the garlic bulb to observe the depth, Fig.

Polar diameter of garlic bulb

The polar diameter of the garlic bulb was relevant to decide the spacing between the rods of the oscillating conveyor. It was the distance between the garlic crown and

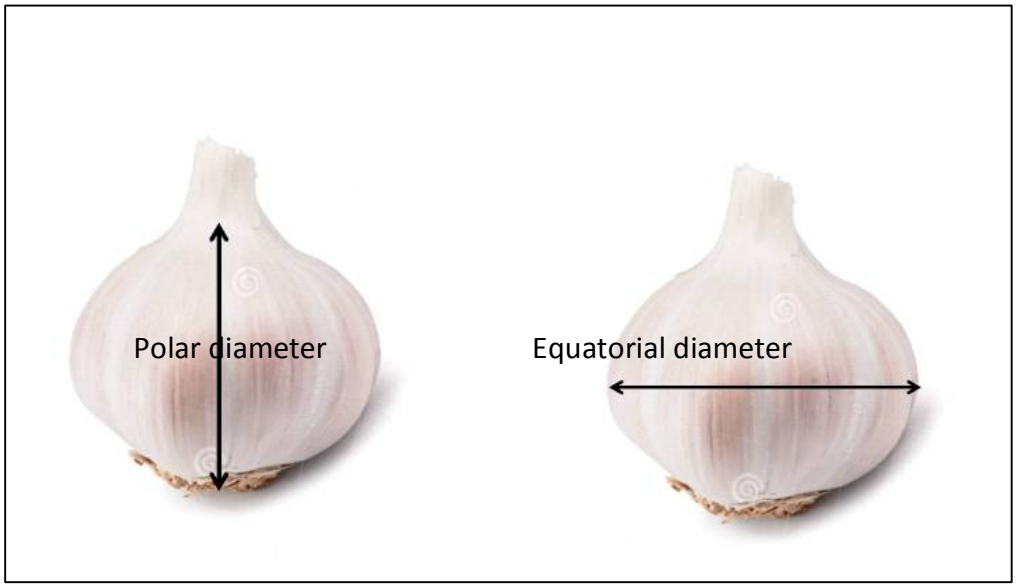

Fig. 2. Polar and equatorial diameter garlic

the point of root attachment to the garlic, Fig 3. The height was measured with digital vernier caliper (least count 0.01mm). Fifteen garlic bulbs were selected randomly and their polar diameter was measured. The maximum, minimum and average of height of garlic bulbs were calculated.

Equatorial diameter of bulb

The equatorial diameter was the maximum width of the garlic in a plane perpendicular to the distance between the garlic crown and the point of root attachment to the garlic, Fig. 3.4. The equatorial diameter of the garlic bulb was relevant to design of the spacing between the rods of the oscillating conveyor. The equatorial diameter of smallest bulb governed the distance between rods of the oscillating conveyor. It was measured using a digital vernier caliper having least count of 0.01 mm. The equatorial diameter was observed by taking fifteen randomly selected garlic plants. The maximum, minimum and average of equatorial diameter of garlic bulbs was determined.

Weight of garlic bulb with leaf

The weight of garlic plant was measured using an electronic weighing balance with least count of 0.01 g for fifteen randomly selected plants, and mean value was determined. The weight of garlic plant would govern the material handling capacity of the soil conveyor of garlic harvester.

Bulk density garlic bulb

Bulk density of garlic bulb is defined as the ratio of weight of garlic bulb to the volume of the same garlic bulb. Bulk density of garlic was required for designing of separating unit. The garlic bulbs were filled in a 1000 cc capacity cylinder without undue pressure and its weight was measured on an electronic balance having least count of 0.1 g. The bulk density was calculated as weight of material per unit volume, g/cc. The average bulk density was determined by taking arithmetic mean of three samples and is shown in Appendix-. Bulk density of garlic was determined by using following equation

$$\text{Bulk density (g/cc)} = \frac{\text{Mass (W2}-\text{W1)}}{\text{Volume of container (V)}} \quad \ldots (3.1)$$

Where,

Table 2. Observations of physical properties of garlic plant

Sr. No.	No of leaves of bulb	Length of garlic leaves, cm	Depth of garlic Bulb below the ground level, cm	Equatorial diameter, mm	Polar diameter, mm	Weight of bulb with leaves, g
1.	8	30.5	6	26.69	26.1	14.4
2.	10	30	6.5	36.2	32.59	30.01
3.	8	27.5	7	30.48	30.07	20.5
4.	12	31.5	7	31.98	28.77	18
5.	10	32	8.5	30.56	29.77	25
6.	9	28	5	30.99	27.33	23
7.	11	29.5	5.5	30.1	28.96	27
8.	10	27	6	28.96	28.92	23
9.	9	27.5	6.5	30.44	29.98	23.5
10.	11	30	6.5	33.12	28.5	29
11.	11	33	7	31.5	25.9	25
12.	8	31.5	7.5	27.05	28.24	20.5
13.	9	28	5.8	30.99	27.33	23
14.	10	29	6	28.96	28.92	23
15.	11	29.5	8	30.1	28.96	27
Max	**12.00**	**33.00**	**8.50**	**36.20**	**32.59**	**30.01**
Min	**8.00**	**27.00**	**5.00**	**26.69**	**25.90**	**14.40**
Average	**9.80**	**29.63**	**6.59**	**30.54**	**28.69**	**23.46**

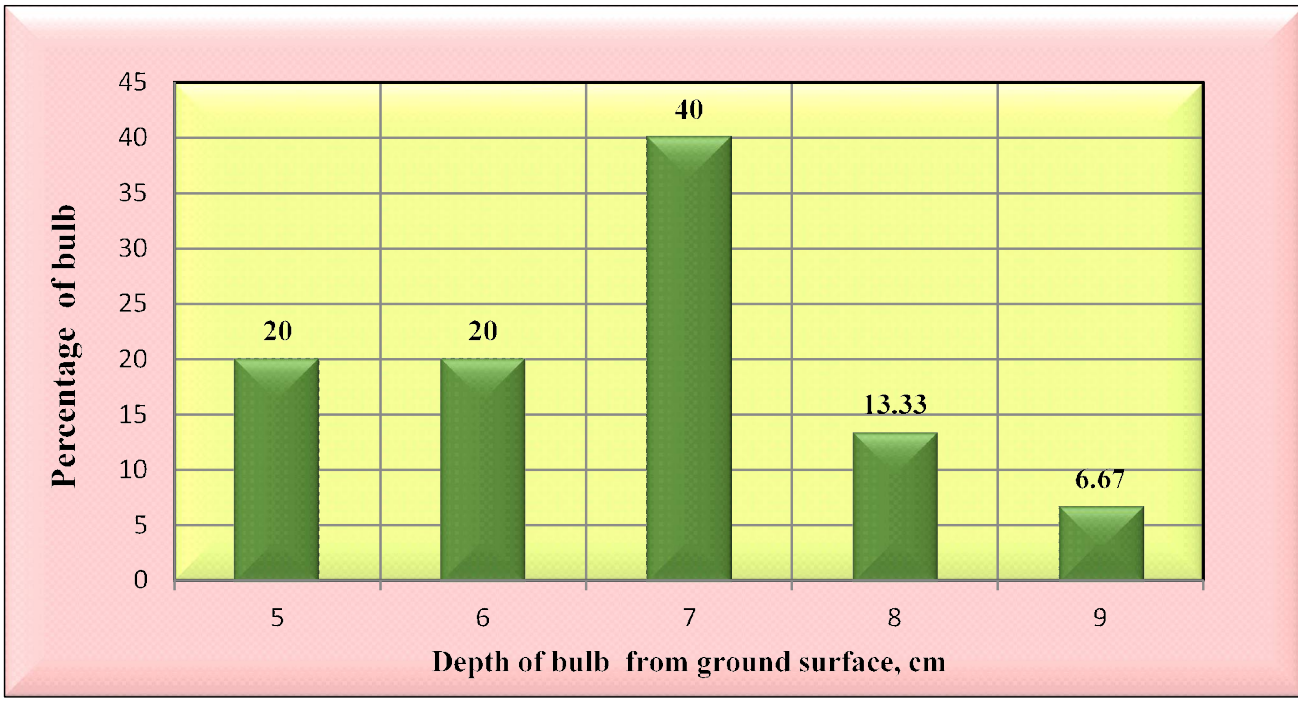

Fig. 3. The percentage distribution of the garlic below the ground surface

W1 = empty weight of container, g

W2 = weight of container filled with garlic bulb, g

V = volume of container, cm^3 (cc)

RESULTS AND DISCUSSION

Physical parameters of garlic relevant to machine design

The size of garlic bulb was relevant parameter to design of the spacing between the rods of the soil separating unit of the prototype garlic harvester. So, physical parameters of plant and bulb of the garlic crop were determined for matured crop. These included number of leaves, Length of garlic leaves, depth of bulb with respect to ground, equatorial and polar diameter and weight of bulb along with leaves, bulk density of garlic bulb, row to row spacing and plant to plant spacing. The data related to these parameters were approximately used in component design. The maximum, minimum and average value of various physical parameters of garlic bulb and plant are

Fig. 4. Measurement of Equilateral Diameter of Garlic

Fig. 5. Measurement of polar diameter of garlic

Represented in Table.

The number of leaves per plant ranged from 8 to 12 with an average of 9.80 and maximum leaves 12. The average length of plant and depth of garlic bulb was 29.63 cm with minimum of 27 cm and maximum of 33 cm. The average depth of the bulb with respect to ground was 6.59 cm with minimum of 5 cm and maximum of 8.50 cm. The percentage distribution of the garlic below the ground surface indicated that 80 per cent bulbs were within 0- 7 cm and 100 per cent within 0-8.5 cm, Fig 4.1.

The observed length of the plant and the number of leaves were used to design the throat of the garlic harvester so that the leaves of the plant are not damaged by the frame of the garlic harvester. This information was used to decide the depth of operation so that maximum garlic bulbs can be dug with minimum damage and by applying just required draft.

The equatorial and polar diameter of the bulb, generally, did not vary much in the garlic bulbs. The average equatorial diameter was 30.54 mm with maximum and

Fig. 6. Measurement of bulk density of soil

minimum value of 36.20 and 26.69 respectively. The average polar diameter of bulbs was 28.69 mm with maximum and minimum value of 32.59 mm and 25.90 mm respectively. Both equatorial and polar average diameter of garlic was found more than 25 mm; it was used to decide the spacing between the bars of conveyor of separating unit.

Properties of soil at garlic harvest

Moisture content of soil

Moisture content of soil was determined using the procedure given in section 3.3. The average Moisture content of soil was obtained as 12.07 % at the time of garlic harvesting. The details of the moisture content of soil are presented in Appendix A.

Bulk density of soil

Bulk density of soil was determined using the procedure given in section 3.3. The Average Bulk density of the soil is indicated in Table 4.2 and the details of the soil bulk density are presented in Appendix A. The average bulk density of soil was recorded 1.45 g cc-1, for garlic field.

CONCLUSIONS

Physical properties of GJG-5 garlic plant such as length of leaves, location of bulb with respect to ground, diameter of the garlic bulb, weight of garlic bulb, and bulk density were determined. These values were used for deciding the dimension of the throat of the harvester, depth of operation, spacing between rods of conveyor and estimate the amount of material handle by conveyor of the harvester.

1. The physical properties of selected garlic variety *i.e.* GJG-5 observed in terms of equatorial diameter, polar diameter, length of garlic leaves, depth of garlic bulb below the ground level, weight of bulb with leaves and bulk density were 30.54mm, 28.69, 29.63 mm, 6.59mm, 23.46 g and0.133 g/cc, respectively.

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Drying Characteristics of Pressure Boiled Turmeric Slices Under Tray and Microwave Drying

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ABSTRACT

Pressure boiling of CO 2 variety of turmeric rhizomes were carried out in an autoclave at pressure levels of 0.25, 0.5, 0.75 and 1kg.cm^{-2}. The Pressure boiled rhizomes were sliced in to 2 mm and 3mm thickness and dried under tray and microwave dryer. The drying characteristics such as drying time and drying rate were studied using moisture loss data and by plotting drying curves . 2mm thick, 1 kg/cm^2 pressure boiled and microwave dried samples recorded the least drying time of 20 minutes and the highest drying rate of 11.9 g.hr $^{-1}$. 3 mm thick, 0.25 kg/cm^{-2} pressure boiled and tray dried samples showed maximum drying time of 12 hours and the least drying rate of 0.22 g.hr^{-1}. The study revealed that slicing of whole rhizomes significantly reduced the drying time. Reduction in slice thickness invariably reduced the drying time and increased the drying rate in all the treatments. Pressure boiling considerably reduced the drying time and drying rate with increase in pressure level. Microwave drying showed the lowest drying time and highest drying rate than tray drying.

Key words *Pressure boiling, Turmeric slices, Tray drying, Microwave drying, Drying rate*

Turmeric is an important spice crop in India and is a major component of many ayurvedic medicines. Curcumin, the major bioactive compound in turmeric has been shown to have anticarcinogenic, anti-inflammatory, antidiabetic and many other biological activities. Turmeric is traditionally processed by boiling in water along with cowdung slurry or boiling in alkaline water followed by sun drying. But the traditional method has numerous disadvantages. It is a very time consuming and less energy efficient process. High labour requirement, losses during handling are also some of the drawbacks of traditional water boiling method. Steam boiling is the most suitable alternative to traditional water boiling and is widely accepted by farmers. Steam boiling can be performed by two methods- open steam boiling or pressure boiling. During pressure boiling water vapor doesn't escape to atmosphere and uniform distribution of steam occurs inside the vessel. Hence Pressure boiling is more time and energy efficient than open steam boiling(Shinde *et al.*, 2011).

Drying rhizomes as a whole is a time consuming process. Borah *et al.*, (2015) found that drying time could be reduced by slicing from his study on drying kinetics of whole and sliced turmeric rhizomes (Curcuma longa L.) in a solar conduction dryer.

Traditional sun drying takes about 10-15 days for drying and it is highly weather dependent. Hot air drying is the most common method for drying of food materials. But it also causes various quality losses such as reduction in colour, taste, and nutrient content in the dried product. The quality loss is due to the exposure of product to a high temperature for a long time. The energy consumption is also high in case of hot air drying. (Bouraoui *et al.*, 1994; Drouzas *et al.*, 1999; Feng and Tang, 1998; Maskan, 2000; Yongsawatdigul and Gunasekaran, 1996).Microwave drying is an innovative drying method which overcomes several drawbacks of sun drying and hot air drying. High energy efficiency, uniform heating, less drying time, improved quality of dried product are the major advantages of microwave drying.

Considering the above facts the present study was carried out to analyze the drying characteristics of pressure boiled turmeric slices under tray and microwave drying methods.

MATERIAL AND METHODS

Pressure boiling

Fresh turmeric rhizomes of CO 2 variety immediately after harvest were purchased from M/S GS farms, Kali Palayam,Coimbatore. Pressure boiling was performed in the laboratory autoclave. One kg of turmeric rhizomes after washing were placed inside the autoclave and steaming was carried out at 0.25 kg.cm^{-2} for 5 min. After steaming the turmeric was divided in to two equal haves of 500 g. One half was cut in to 2 mm thick and another half in to 3mm thick. The steaming was repeated at 0.5, 0.75, and 1 kg.cm^{-2} respectively and slicing in to 2mm and 3mm thickness was also repeated. The sliced turmeric were dried in tray drier and microwave oven. Pressure boiled rhizomes were sliced using a thickness adjustable vegetable slicer. The slicing was carried out at 2mm and 3mm thickness. The thickness of the slices were measured using Vernier caliper.

Drying of Rhizomes

Tray drying of boiled turmeric slices were performed in a tray drier. The temperature was fixed at 60^{0}C based on the results obtained by Singh *et al.* (2010). The initial weight of samples were taken and the rhizomes were spread uniformly on trays. The weight at each 1 hour interval was taken for the drying calculation. Drying was performed until the moisture content reached below 10% and the slices breaks with a metallic sound. Microwave drying was performed in microwave oven (IFB 23SC1 model) of 800 W output capacity with provision to adjust power level and time. 250 g of sliced rhizomes were kept over a circular glass plate inside the drying chamber. Preliminary study was carried out at 40, 50 and 60% power levels in order to optimize the power level. Based on colour value and results

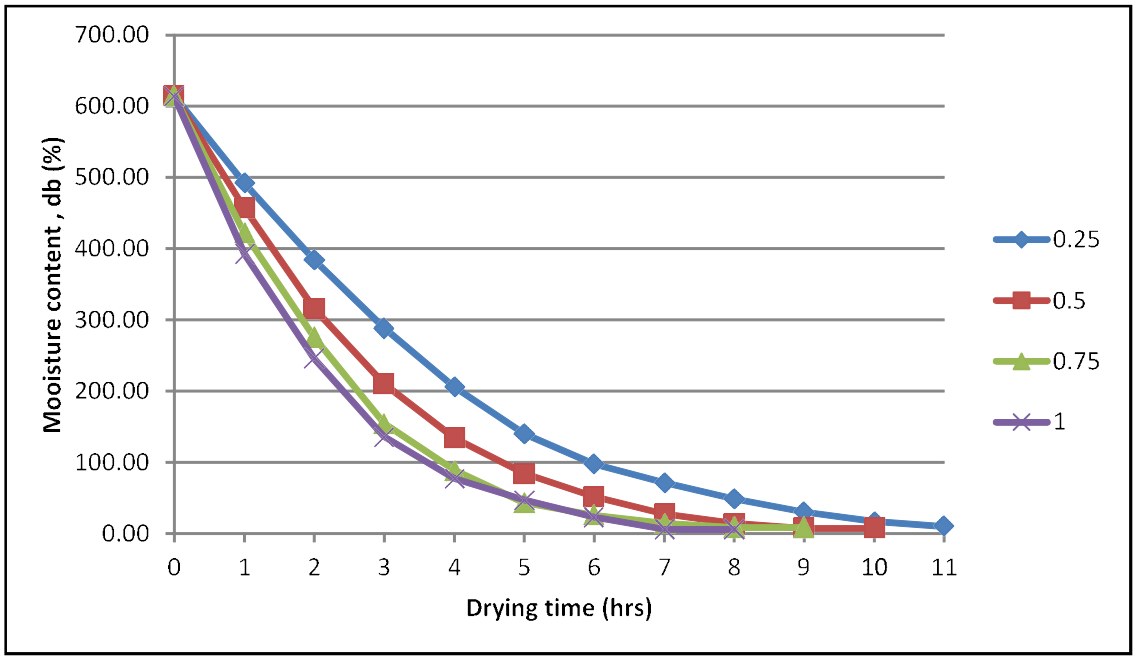
Table 1. Average drying rate (g.hr^{-1}) of pressure boiled samples under different slice thickness and drying methods

Boiling pressure	T1		T2	
Drying method	**D1**	**D2**	**D1**	**D2**
B1	0.26	6.39	0.22	4.18
B2	0.32	8.7	0.26	5.66
B3	0.37	9.03	0.33	5.76
B4	0.45	11.99	0.39	7.13

T1- 2 mm T2 – 3 mm

D1- Tray drying D2- Microwave drying

B1- 0.25 kg.cm $^{-2}$ B2- 0.5 kg.cm^{-2} B3-0.75 kg.cm $^{-2}$ B4- 1 kg.cm^{-2}



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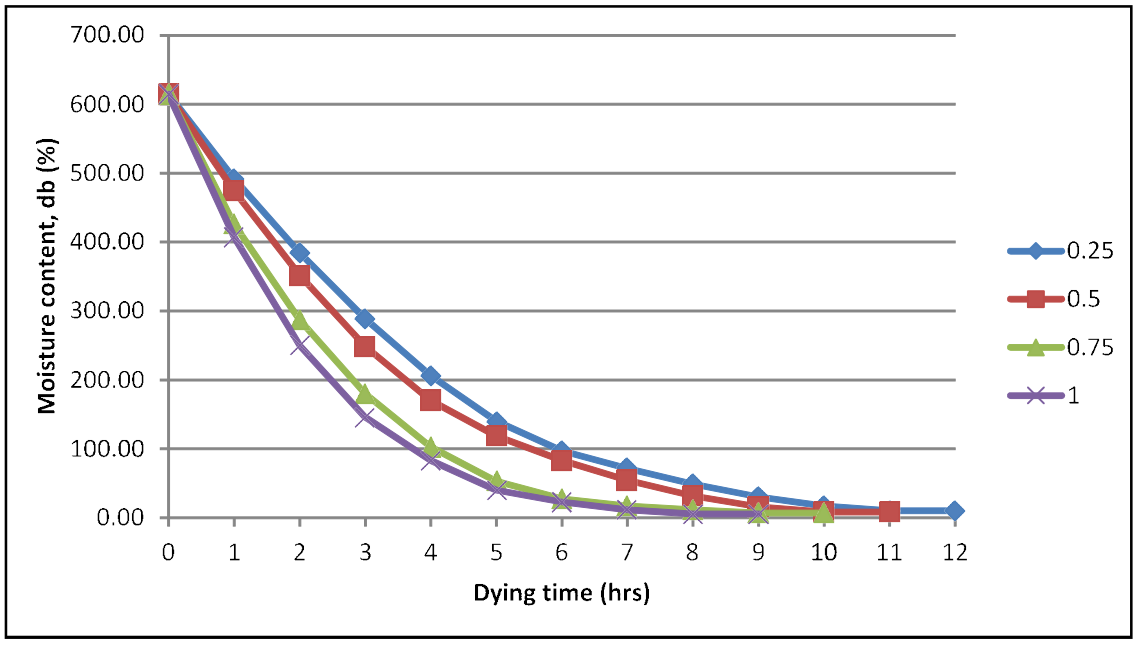
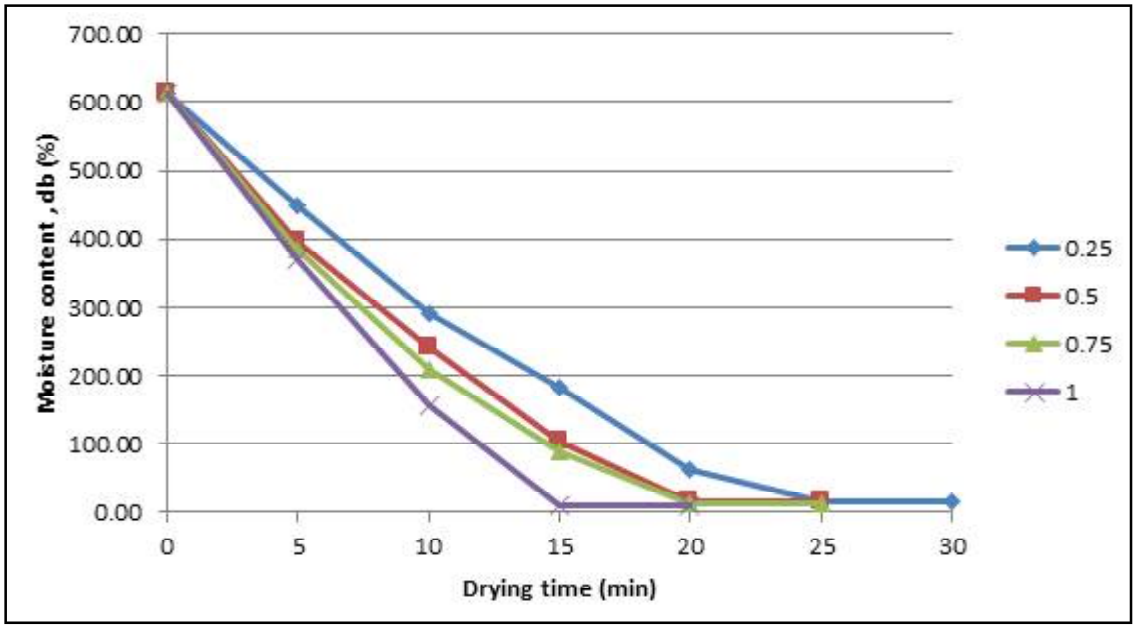


(b)

Fig.1. Effect of different boiling pressures on moisture content and drying time of tray dried samples under different thickness : (a) 2mm (b) 3mm



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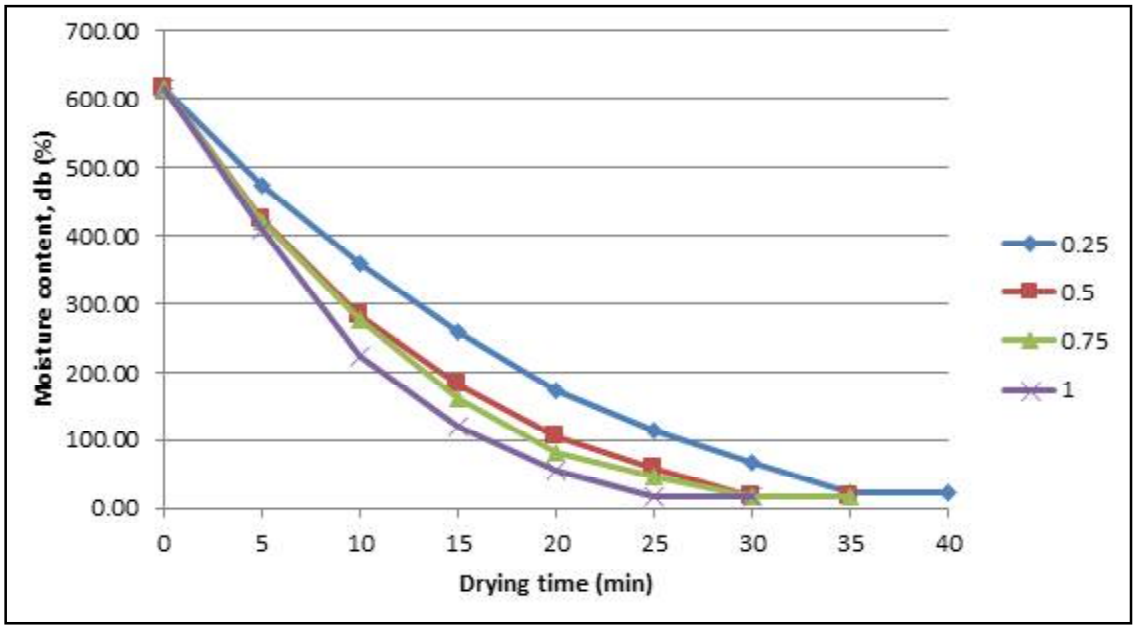


(b)

Fig.2. Effect of different boiling pressures on moisture content and drying time of microwave dried samples under different slice thickness: (a) 2mm (b) 3mm

by Assawarachan *et al.* (2013), power level was fixed as 50 % (400W) and time as 5 min for operation of microwave oven. An air blower is attached to the drying chamber in order to cool the magnetron during operation. The weight of rhizomes were noted in each 5 min interval. The drying was continued until the moisture content reached to 10%.Dried turmeric slices were packed in 42 micron thick, small size (21.3cm × 18 cm) fresh-n-loc Zipouches (Uflex Ltd).

Drying Characteristics

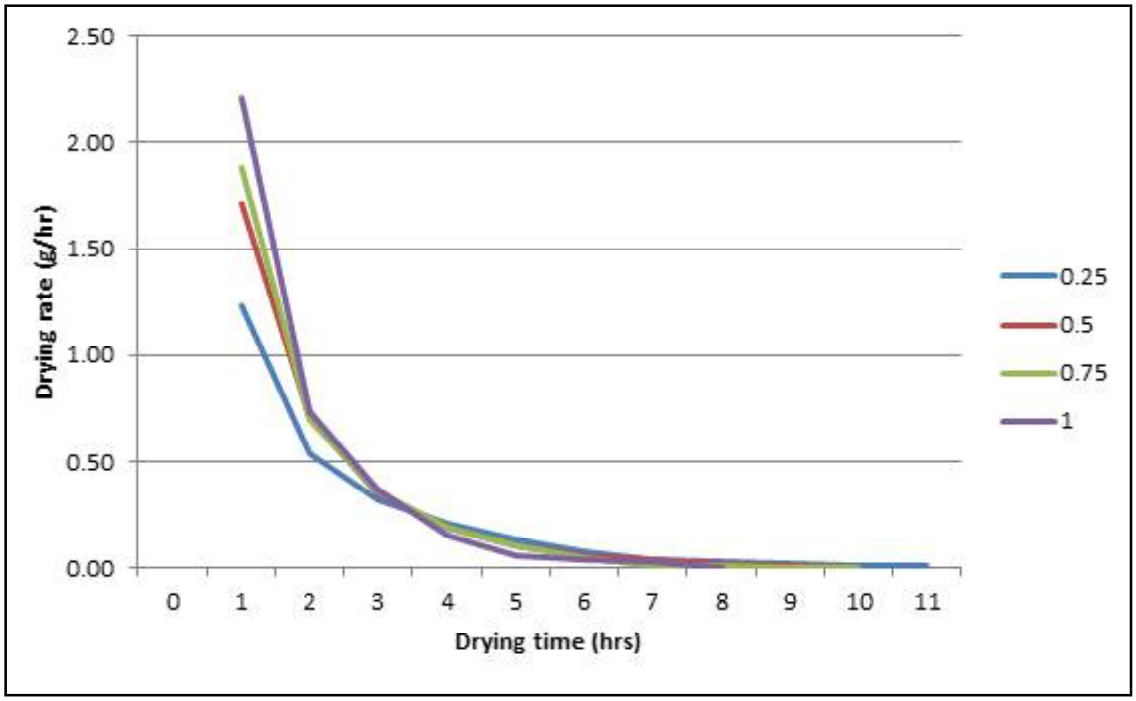
Drying characteristics of pressure boiled samples were determined by conducting tray drying and microwave drying studies. The weight loss data was used for moisture content and drying rate calculation. Drying curves were plotted on the basis of this calculation.

Moisture content

Change in weight was recorded at regular intervals during drying. Readings were taken until the weight reached a constant value. The moisture content can be expressed on wet basis and dry basis using the following equations.

The moisture content on wet basis,

$$M = \frac{w(t)-d}{w} \times 100 \quad \text{——————(1)}$$



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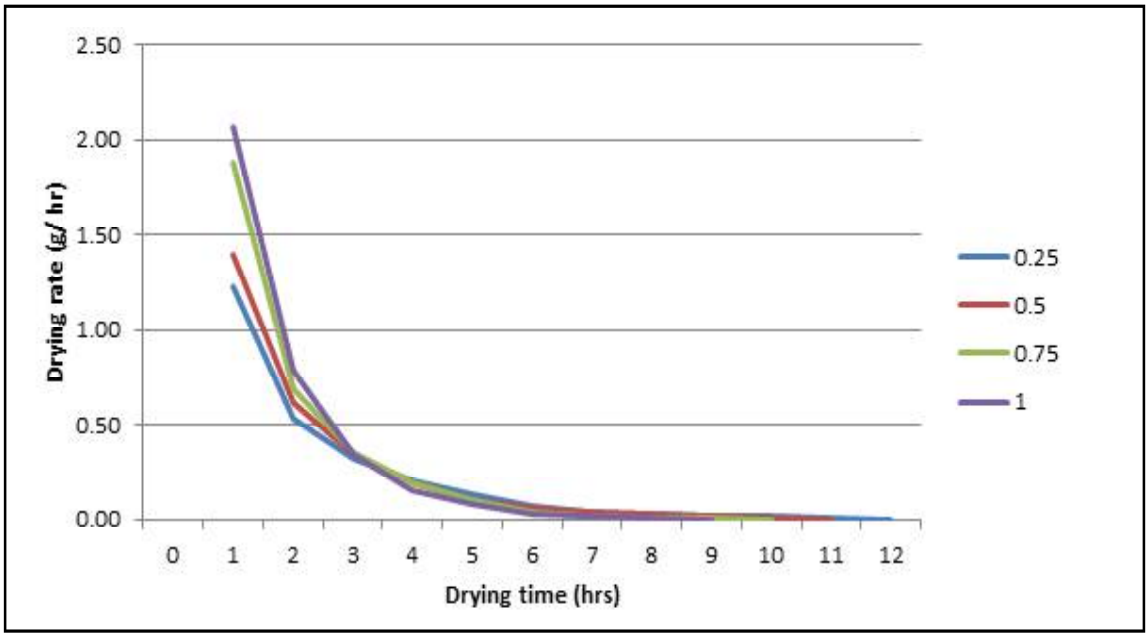


(b)

Fig.3. Effect of different boiling pressures on drying rate of tray dried samples under different thickness: (a) 2mm (b) 3mm

The moisture content on dry basis,

$$M = \frac{w(t)-d}{d} \times 100 \quad \text{——————(2)}$$

w(t) is the mass of wet material at instant time (t) and d is the mass of dry material

Drying rate

Drying rate was calculated using following expression

$$Rd = \frac{Mi-Md}{t} \quad \text{——————(3)}$$

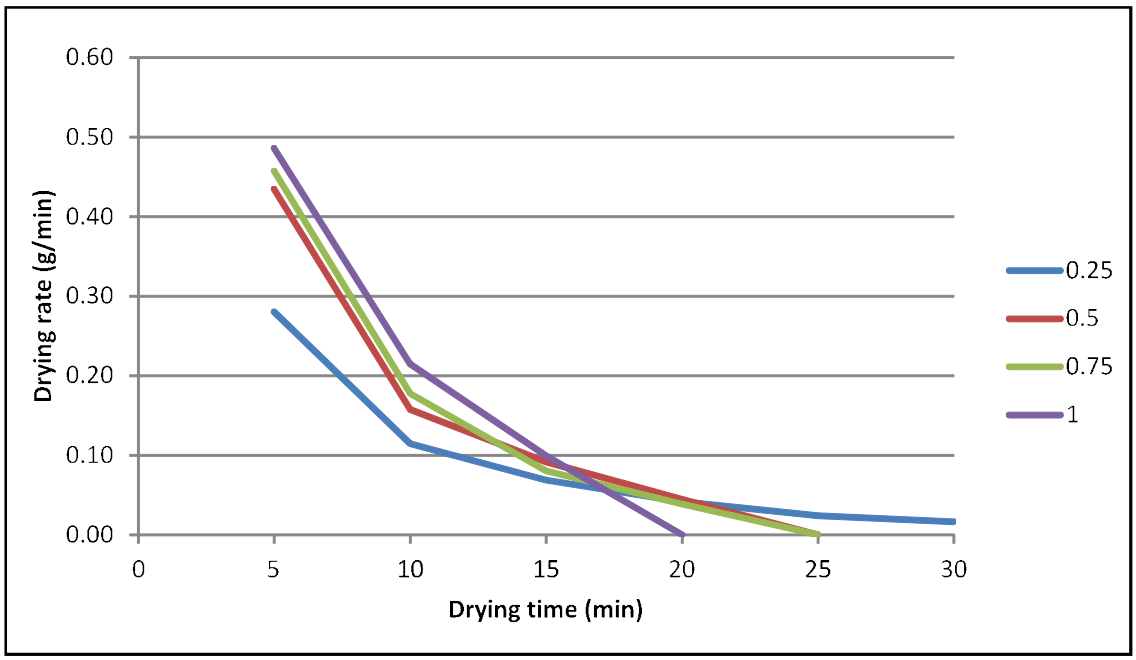
Mi is the mass of sample before drying and Md is the mass of sample after drying t is the time of drying

RESULTS AND DISCUSSION

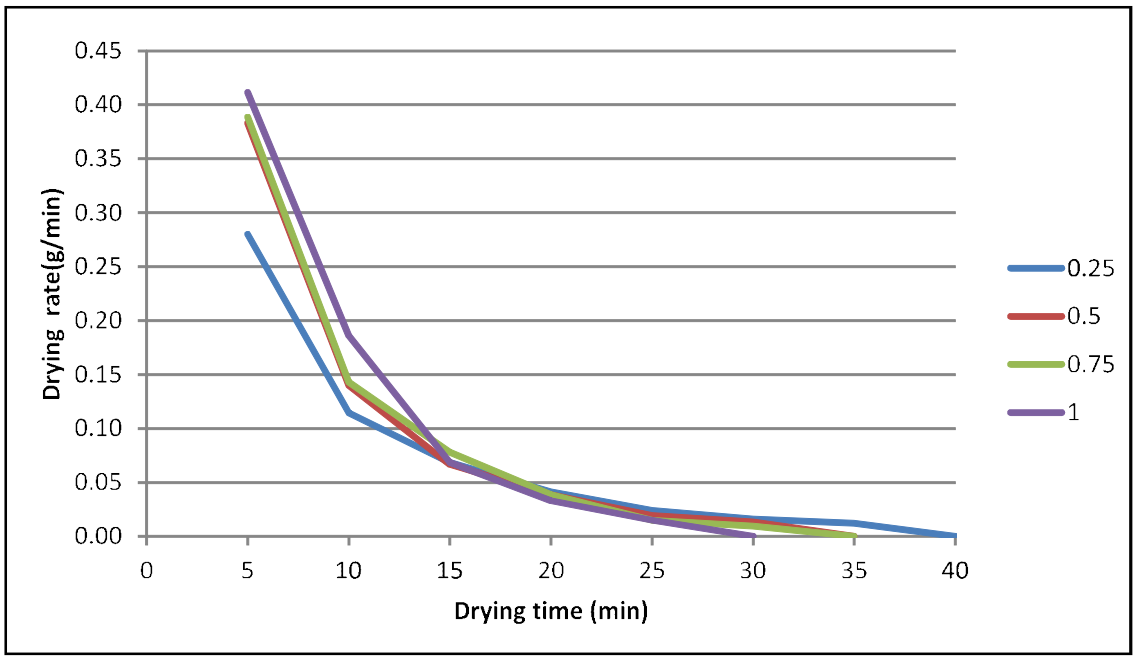
Drying characteristics of pressure boiled Rhizomes under different slice thickness and drying methods

Drying time

Fig.1 and 2, represent the effect of different boiling pressures on moisture content and drying time of tray and microwave dried samples under different thickness. In both the drying methods, drying took place in falling rate period.



(a)



(b)

Fig.4. Effect of different boiling pressures on drying rate of microwave dried samples under different thickness:

During the falling rate period, material surface is no longer saturated with water and drying rate is controlled by diffusion of moisture from the interior of solid to surface (Diamante and Munro, 1993). Under the same drying method and boiling pressure, the drying time was lower for 2 mm thick samples compared to 3 mm thick samples. Reduction in slice thickness resulted in reduction in drying time since the distance travelled by moisture to the surface is less at lower thickness.

During tray drying, 2 mm thick samples boiled at 0.25 kg.cm^{-2} took 11 hours for drying whereas those boiled at 1 kg.cm^{-2} dried within 8 hours. During microwave drying 2 mm thick samples boiled at 0.25 kg.cm^{-2} took 30 min for drying whereas those boiled at 1 kg.cm^{-2} dried with in 20 min. 3mm thick samples also showed the same behavior. Hence it was observed that samples boiled at higher pressures dried faster than those boiled at lower pressures. It might be due to the fact that at higher pressures and temperature, most of the water got evaporated and hence drying took place faster. Curing or boiling causes gelatinization of starch and this gelatinized starch shrink during drying which will increase the intracellular space

and enhance water diffusion and results in short drying time (Praditdoung *et al.*, 1996). Microwave drying took least time (20 min) for drying while tray drying required more time for drying (12 hours).

Drying rate

Fig 3 and 4 represent the effect of different boiling pressures on drying rate of tray and microwave dried samples under different slice thickness. Drying rate was high during initial stages and gradually decreased with time. Table 1 represent the average drying rate of pressure boiled samples under different slice thickness and drying methods. 2mm thick, microwave dried samples boiled at 1 $kg.cm^{-2}$ showed the highest drying rate of 11.99 $g.hr^{-1}$. The 3 mm thick, tray dried samples boiled at 0.25 $kg.cm^{-2}$ showed the lowest drying rate of 0.22 $g.hr^{-1}$.

CONCLUSION

The slice thickness, pressure boiling and drying methods used in the study showed a significant effect on the drying characteristics of turmeric. Slicing of whole rhizomes in to thin slices considerably reduced the drying time and increased the drying rate. 2 mm thick samples showed lower drying time and higher drying rate compared to 3mm thick samples. Samples boiled at higher pressure showed a lower drying time and higher drying rate than those boiled at lower pressure. Among the drying methods used, microwave drying showed least drying time and maximum drying rate. 2mm thick, 1 $kg.cm^{-2}$ pressure boiled and microwave dried samples recorded the least drying time of 20 minutes and the highest drying rate of 11.9 $g.hr^{-1}$.

LITERATURE CITED

Assawarachan, R., Kalayanamitra, K., and Keokamnerd, T. 2013. *Modeling and Optimization of Microwave Drying of Turmeric Slices*. Paper presented at the II Southeast Asia Symposium on Quality Management in Postharvest Systems 1088.

Borah, A., Hazarika, K., and Khayer, S. 2015. Drying kinetics of whole and sliced turmeric rhizomes (Curcuma longa L.) in a solar conduction dryer. *Information Processing in Agriculture,* **2**(2), 85-92.

Bouraoui, M., Richard, P., and Durance, T. 1994. Microwave and convective drying of potato slices. *Journal of Food Process Engineering,* **17**(3), 353-363.

Diamante, L. M., and Munro, P. A. 1993. Mathematical modelling of the thin layer solar drying of sweet potato slices. *Solar energy,* **51**(4), 271-276.

Drouzas, A., Tsami, E., and Saravacos, G. 1999. Microwave/vacuum drying of model fruit gels. *Journal of Food Engineering,* **39**(2), 117-122.

Feng, H., and Tang, J. 1998. Microwave finish drying of diced apples in a spouted bed. *Journal of Food Science,* **63**(4), 679-683.

Maskan, M. 2000. Microwave/air and microwave finish drying of banana. *Journal of food engineering,* **44**(2), 71-78.

Praditdoung, S., Kaewmanee, P., Ganjanagoonchorn, W., and Wanichgarnjanakul, K. 1996. Effect of curing on turmeric tissue and drying time. *Witthayasan Kasetsart (Sakha Witthayasat)*.

Shinde, G. U., Kamble, K. J., Harkari, M. G., and More, G. 2011. *Process optimization in turmeric heat treatment by design and fabrication of blancher.* Paper presented at the International Conference on Environmental and Agriculture Engineering. IPCBEE.

Singh, Arora, S., and Kumar, S. 2010. Effect of mechanical drying air conditions on quality of turmeric powder. *Journal of food science and technology,* **47**(3), 347-350.

Yongsawatdigul, J., and Gunasekaran, S. 1996. Microwave vacuum drying of cranberries: part ii. quality evaluation. *Journal of Food Processing and Preservation,* **20**(2), 145-156.

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Cluster Analysis in Chilli Accessions (*Capsicum frutescens* L.)

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ABSTRACT

Seventy eight genotypes were subjected to Mahalanobis D^2 statistics to study genetic divergence and they were grouped into nine clusters on the basis of D^2 values using Euclidean^2 method. Cluster II accommodated maximum number (24) of genotypes and minimum with cluster III (1 genotype). The maximum relative contribution to the total divergence was made by fruit yield per plant (61.07 %) and cluster VIII and cluster IX may be taken into consideration as better parents for an efficient hybridization programme of chilli. The inter cluster distances (D values) ranged between 3.90 to12.68 Intercrossing among the genotypes belonging to cluster III, VIII and IX was suggested to develop high yielding varieties with resistance to leaf curl or may be used as potential donors for future hybridization programme to develop better chilli variety with good fruit yield. The maximum relative contribution to the total divergence was made by fruit yield per plant (61.07 %)

Keywords *Chilli, Capsicum frutescens, Genetic diversity, Resistance and Cluster*

Chilli is a widely used vegetable or spice crop cultivated throughout India. It is consumed both in unripe (green) and ripe (red) forms. Chilli is a rich source of vitamin C. It also contains vitamin A, vitamin B and minerals. India is the leading country in the production of chillies contributing 41.11 per cent of the world's production. Bird chilli (*Capsicum frutescens* L.) or bird's eye chilli is a stimulating herb renowned for aroma, taste, flavour and pungency. Pungency in chilli is due to presence of an alkaloid "capsaicin" contained in the pericarp and placenta of fruits. In India chilli is cultivated in 7. 94 lakhs ha, production is 1304 million tonnes and its productivity is 1.6 million tonnes per ha. India is the only country which is rich in many chilli varieties with different quality factors. A wide variability in chilli fruit morphology, pungency, bearing habit and crop duration is found throughout India. Leaf curl is considered to be one of the major limiting factors in chilli production. Collection and evaluation of genotypes for high yield and resistance to biotic stress are important in crop improvement.

Genetic divergence existing in the population helps in selection of suitable parents for any crop breeding programme, leading to reduction in the number of crosses. Selection of parents depends on specific objective of the research programme and their performance. Various statistical analyses are available to select suitable parents. Mohalanobis D^2 statistic of multivariate analysis is recognized as a powerful tool in quantifying the degree of genetic divergence among the populations. The information on the nature and degree of genetic divergence is essential for the breeder to choose the right type of parents for purposeful hybridization in heterosis breeding. In order to benefit transgressive segregation, the knowledge of genetic distance between parents is necessary. Therefore, the present study was undertaken to assess the genetic diversity in 78 genotypes of chilli and to identify suitable donors for a successful breeding program in this crop.

MATERIALS AND METHODS

Seventy eight chilli (*Capsicum frutescens* L.) genotypes were collected from different part of Kerala and cultivated in the experimental field at Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, during September-February, 2013-14. The four weeks old seedlings were transplanted in a spacing of 50cm × 50cm between rows and 75cm × 75cm between plants. Timely management practices as per the package of practices recommendations of Kerala Agricultural University were carried out. The observations were recorded on five randomly selected plants of each genotype on number of days to first flowering, number of primary branches, number of secondary branches, number of fruits per plant, average fruit length (cm), average fruit width (cm), individual fruit weight (g), fruit yield per plant(g), number of seeds per fruit, plant height (cm), incidence of leaf curl disease, number of white flies per plant, number of aphids per plant, number of thrips per leaf, number of mites per leaf and leaf pubescence.

Vulnerability index is calculated on the basis of leaf curl virus disease scoring 0 to 4 scale. Leaf pubescence was observed on the youngest mature leaves and it was classified as sparse (3), intermediate (5) and dense (7). Mahanalobis D^2 statistics was used for assessing the genetic divergence between the groups. The grouping of the population was done by using squared Euclidean distance.

RESULTS AND DISCUSSION

Cluster II was the largest one comprising of twenty four genotypes followed by cluster IV with 13 genotypes, cluster I with 11 genotypes, cluster V with 9 genotypes, cluster IX with 8 genotypes, cluster VI with 7 genotypes, cluster VII with 3 genotypes, cluster VIII with 2 genotypes and cluster III with 1 genotype, indicating high degree of heterogeneity among the genotypes. This was supported by in a Study of genetic diversity in 30 chilli genotypes and they were grouped into 6 clusters. studied 54 chilli genotypes which were fallen into seven clusters. The selection of genotypes for hybridization should be based on genetic divergence rather than geographical diversity.

The inter-cluster distance was maximum between cluster VII and VIII (12.68) indicating wide genetic diversity

Table 1. D values

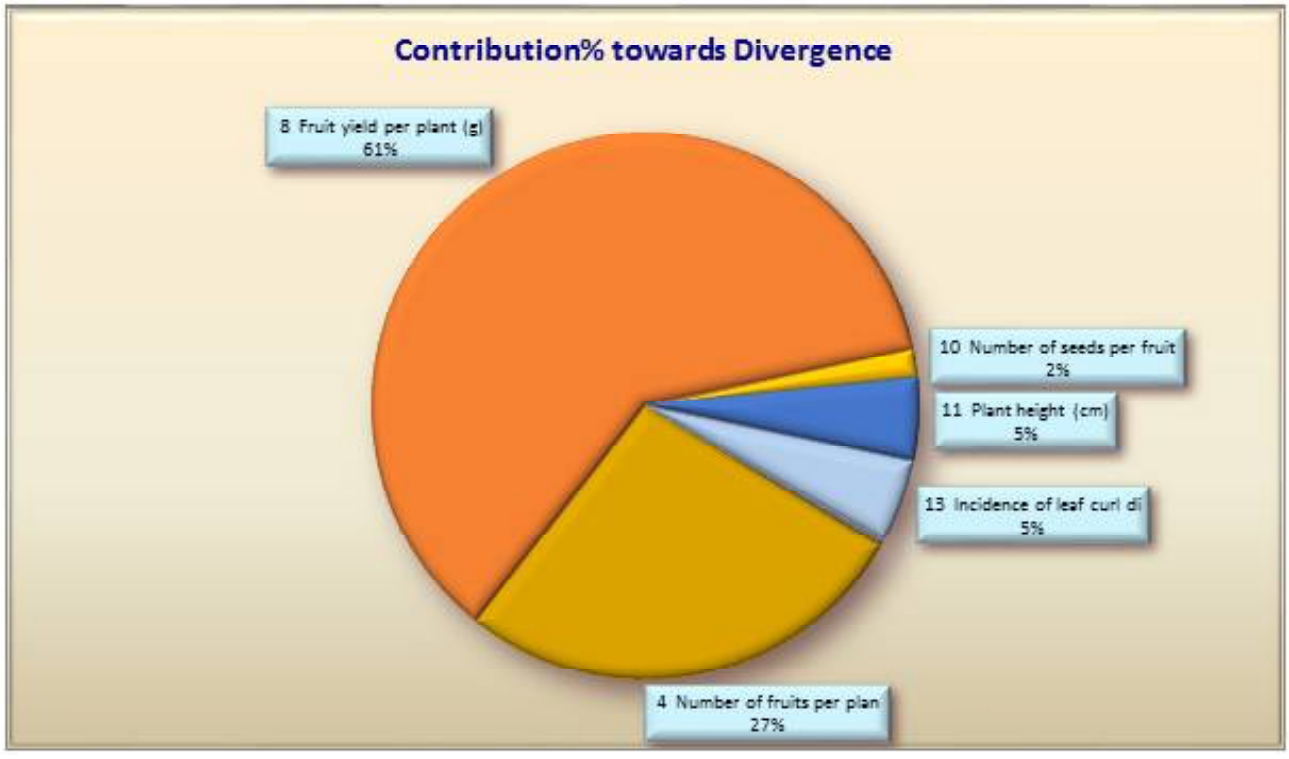
Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	4.25	4.84	6.09	4.64	5.18	5.23	7.16	10.74	6.70
II		3.38	5.53	3.90	4.16	4.46	7.03	11.70	6.98
III			0.00	6.29	5.98	5.94	7.81	9.07	6.02
IV				3.51	4.04	4.46	6.93	11.67	7.09
V					3.32	4.60	6.71	12.41	7.54
VI						3.89	7.39	11.76	7.17
VII							4.62	12.68	8.88
VIII								5.45	7.2
IX									3.57

between these two clusters. The hybrids of genotypes with maximum distance resulted in high yield. Thus the cross between the genotypes from cluster VII and VIII can be used in chilli breeding to achieve maximum heterosis. Genotypes from these two clusters if involved in hybridization, may result in a wide spectrum of segregating populations as genetic diversity is very distinct among the groups. The selection of diverge genotypes from a cluster would produce a broad spectrum of variability for morphological and quality traits studied which may enable further selection and improvement. Minimum inter cluster distance between cluster II and IV (3.90) indicated that the genotypes were genetically close to each other. The intra cluster divergence varied from 3.32 to 5.45. Maximum intra cluster distance was achieved in cluster VIII (5.45) which comprised two genotypes while minimum divergence was observed in cluster V (3.32). Cluster III showed zero intra cluster distance due to containing only one genotype.

The maximum relative contribution to the total divergence was made by fruits yield per plant (61.07 %), number of fruits per plant (27.11 %), plant height (4.86 %) incidence of leaf curl disease (4.83 %), number of seeds per fruits (1.67 %), number of secondary branches (0.37 %) and number of days to first flowering (0.10 %).

CONCLUSION

Crossing between cluster VIII genotypes and cluster IX genotypes, cluster III and cluster VIII and cluster III and cluster IX may be suggested to be useful for future hybridization programmes. Superior genotypes,



Graph. Percentage contribution towards divergence

Table 2. Distribution of 78 Chili genotypes in different clusters

Cluster No	No of genotypes	Cluster members
I	11	A1, A51, A16, A72, A12, A43, A23, A37, A39, A11, A40
II	24	A2, A25, A27, A8, A6, A64, A9, A58, A5, A54, A68, A33, A60, A19, A46, A47, A61, A17, A44, A18, A59, A65, A20, A35
III	1	A13
IV	13	A3, A35, A78, A66, A73, A49, A63, A69, A48, A14, A56, A21, A36,
V	9	A15, A22, A74, A77, A76, A53, A67, A10, A71
VI	7	A30, A31, A7, A41, A32, A73, A42
VII	3	A26, A38, A75
VIII	2	A4, A50
IX	8	A24, A28, A34, A52, A55, A57, A62, A70

Vandithadam-I and Kumarapuram-I fallen in cluster VIII had shown best results on fruit yield per plant (g), followed by number of fruits per plant, plant height (cm), number of days to first flowering, number of secondary branches, number of primary branches, average fruit length (cm), average fruit width (cm) individual fruit weight (g) and less incidence of leaf curl disease. Hence, these characters should be given prime importance for further crop improvement programmes *i.e* interspecific hybridisation with *Capsicum annuum* to develop the resistant genotypes for leaf curl virus.

LITERATURE CITED

Anandhi, K. 2010. Genetic analysis of yield and leaf curl virus resistance in chilli (*Capsicum spp*.) Ph.D. thesis, Kerala Agricultural University, Thrissur, 59p.

Farhad, M. Hasanuzzaman, M. Biswas, B.K. Arifuzzaman, M. and Islam, M.M. 2010. Genetic divergence in chilli. *Bangladesh Res. Pub. J*. **3** (3): 1045-1051.

Hasan, M.J. Kulsum, M.U. Ullah, M.Z. Hossain, M.M. and Mahmud, M.E. 2014. Genetic Diversity of Some Chili (*Capsicum annuum* L.) Genotypes. *Int. J. Agril. Res. Innov. & Technol*. **4** (1): 32-35.

Julia, Y.S. Tyagi, W. Pandey, A. Meetei, N.T. and Rai, M. 2012. Evaluation of genetic diversity of chilli landraces from North Eastern India based on morphology, SSR markers and the Pun1 Locus. *Plant Mol. Biol. Rep*. **30** (6):1470- 1479.

KAU (Kerala Agricultural University). 2011. Package of practices Recommendations: Crops (14th Ed). Kerala Agricultural University, Thrissur, 180p.

Khodadabi, M. Fotokian, M. and Miransari, M. 2011. Genetic diversity of wheat genotypes based on cluster and principal component analyses for breeding strategies. *Australian J. Crop Sci.* **5**(1): 17-24

Kumar, B. 2013. Indian Horticulture Database-2013, (eds). Mistry, N. C., Singh, B. and Gandhi, P. C. pp. 6.

Kumar, B. Lal, G. Ruchi, M. and Upadhyay, A. 2009. Genetic variability, diversity and association of quantitative traits with grain yield in bread wheat *(Triticum aestivum* L.). *Asian J. Agril Sci.* **1** (1): 4-6

Kumar, B.M. Kantti, A. and Mallikarjunaiah, H. 2010. Genetic divergence in chilli accessions. *Electr. J. Plant Breed*. **1** (5): 1363- 1366.

Lahbib, K. Bnejdi, F. and Gazzah, M.E. 2013. Selection of pepper parent from a collection of *Capsicum annuum* landraces based on genetic diversity. *J. Plant Breed. and Crop Sci.* **5** (5): 68-72.

Mahalanobis, P.C. 1936. On the generalized distance in Statistics. *Proc. Nat. Inst. Sci. India* **2**:49-55.

Pandit, M.K. and Adhikary, S. 2014. Variability and Heritability Estimates in Some Reproductive Characters and Yield in Chilli (*Capsicum annuum* L.) *Int. J. Plant and Soil Sci.* **3** (7): 845-853.

Singh, S.P. 2007. Production and management of spices. Agrihortica Publications, Junagadh, pp. 171-190.

Yatung, T. Dubey, K.R., Singh, V. and Upadhyay, G. 2014. Genetic diversity of chilli (*Capsicum annuum* L.) genotypes of India based on morpho-chemical traits. *Aust. J. Crop Sci.* **8** (1): 97-102.

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Effect of Foliar Application of KNO3, Ethrel and Nitrogen on Fruit Parameters, Yield and Quality of Fruit Crops

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ABSTRACT

In tropical and subtropical regions, the area under fruit production is increasing day by day. But due to some limitations like; irregular or erratic flowering, low fruit set as well as fruit retention leading to low yield and fruits of poor quality and short availability period are also the main problems in mango production. Certain chemical sprays found very effective for the reduction of intensity and losses due to these limitations. Foliar application of KNO_3, Ethrel and urea significantly increase the flowering percentage, induce early flowering and reduced alternate bearing which improves the fruit characters, yield and quality parameters of the fruits. Ethrel release ethylene gas and turn triggering the mechanism of flowering. In addition, urea spray was reported to be helpful for better retention of flowering in certain crops. It is also observed that delayed flowering in mango fail to fetch attractive price from the market. Delayed flowering also have risk due to early rainfall, which may bring fruit drop and deterioration in quality. Finally, because of early and more flowering and nourishment with nitrogenous compound and also due to beneficial effect of Etheral the final retention is increased which leads tree towards the increase in yield and improvement in fruit characters along with quality parameters. These will help growers for the socio-economic up-liftment.

Key words *KNO_3, Ethrel, Urea, fruiting, yield, quality.*

Now days in India fruit growing is a developing trend among horticulturists, though it is an indigenous practice for human being. It is developed and still developing culture for growers. It is the most important fruit crop of the country. For fetching higher price in the market, production of high quality produce is of most importance. Apart from orchard management, cultural practices and post-harvest treatment, proper time of harvesting play an important role for quality production and planning for commercial marketing. The mango inflorescence is primarily terminal, although axillary and multiple panicles may also arise from axillary buds. It is a much branched panicle bearing many very small (4 mm) greenish white or pinkish flowers. Application of KNO_3 advanced flowering and harvesting date, increased yields and reduce alternate bearing (Sergent *et al*., 1997 and Sharma *et al*., 1990a) obtain maximum number of fruits per plant and fruit weight of mango by urea application. Ethrel release ethylene gas when it comes in to contact with the plant tissues in turn triggering the mechanism of flowering and may break dormancy of shoots. An ethylene release chemical help in induction of flowering in 'off' year mango (Pandey *et al*., 1973).

In general, it is observed that delayed flowering in fruit crops mango fail to fetch attractive price from the market. Delayed flowering also have risk due to early rainfall, which may bring fruit drop and deterioration in quality. One of the major problems among mango growers is fruit drop at various stages, till it reaches maturity.

Effect of KNO_3 on fruiting and yield

Singh and Tripathi (1978) sprayed Banarasi and Langra mango trees three time with KNO_3 + NaH_2PO_4 at various concentration up to 5 per cent and 1 per cent, respectively at weekly interval after panicle emergence and observed increased fruit size. Nunez (1985) estimated that pre flowering spray of urea and KNO_3 on mango gave increase in number of fruits retained per panicle. Oosthuyse (1991) studied that KNO_3 application noticeably increase fruit retention, average fruit mass, yield and monetary return in mango. Oosthuyse (1997) reported that the fruit retention can be increased by single or double sprays of KNO_3 during flowering in mango cvs. Tommy Atkins, Heidi and Kent. Gupta and Brahmachari (2004) found that the increase in fruit retention percentage of Bombai mango by the application of 4 per cent KNO_3. Sudha *et al.* (2012) gave foliar application of various nitrogenous chemicals in mango cv. Alphanso and noticed that KNO_3 at 2 per cent obtained maximum number of flowering shoots (68.7 per cent), number of panicles (7.5/m^2), panicle length (31.4 cm), number of hermaphrodite flowers (282.5/panicle), fruit set (17.0 per cent), number of fruits (146.0/tree) and fruit yield (43.8 kg/tree). Amarcholi*et al.* (2016) investigated to know the influence of chemicals on fruiting characteristics of 'Kesar' mango and found that foliar application of KNO_3 (1 per cent) gave maximum fruit set percentage (0.21 per cent), fruit retention percentage (20.45 per cent) and fruit yield (11.30 t/ha).

Sharma *et al*. (1990a) reported that sprays of Urea (2 and 4 per cent) and KNO_3 (1.5 and 3 per cent) during flowering significantly enhanced fruit yield in mango cv. 'Langra'. Sanyal *et al*. (1996) observed higher yield as

compared to control during 'off" year in 'Himsagar' and 'Langra' mango trees which was noted with four foliar applications of KNO_3 (10t mg/l) at monthly interval between September and December. Patoliya*et al*. (2017) reported that KNO_3 (2 per cent) gave maximum number of fruits, average fruit weight and yield (kg/tree) as compared to untreated tree. In case of quality parameter like TSS, total sugar, non-reducing sugar, reducing sugar also improved by KNO_3 (2 per cent) in Dashehari mango.

Effect of Ethrel on fruiting and yield

Hafle*et al*. (2003) studied the effect of ethrel (4 applications of 2.25 ml/liter), KNO_3 (2 applications of 0.25 ml/liter) + calcium nitrate (2 applications of 30 g/liter) and ethrel (2 applications of 0.25 ml/liter) + potassium nitrate (2 applications of 30 g/liter) in the flower production of Tommy Atkins mango. The result indicated that combine application of calcium nitrate and potassium nitrate affect percentage of flowered branches, number of fruits per plant, average weight of fruits, number of fruit per plant and productivity of fruits. Stephen *et al*. (2017) reported that KNO_3 and ethephon increased fruit set in both 'Ngowe' and 'Apple' mango trees with 4 per cent KNO_3 and 1000 ppm of ethephon resulting in highest fruit set in both varieties.

Brahmachari*et al.* (1995) reported that application of ethrel at 25 and 50 ppm in guava enchanced fruit set percentage and yield.

Effect of urea on fruiting and yield

Rajput and Tiwari (1975) reported that foliar sprays of 2, 4 and 6 per cent urea improved fruit weight of Langra, Dashehari and Totapuri. Fruit weight was maximized at 4 per cent urea with Dashehari and Totapuri. Shawky*et al*. (1978) observed increased fruit set in Taimur mango with urea spray. Chandra (1988) mentioned that the foliar spray of urea 2 per cent reduced fruit drop in Dashehari and Langra mango. Singh and Ahlawat (1996) reported that the foliar application of urea (1.5 per cent) has favorable effect in minimizing the fruit drop in Ber cv. Umran and also found favorable effect on breath and average weight of fruit. Ahmad *et al*. (1998) studied that in guava the highest average fruit weight was obtained at 2 per cent urea spray. Amro*et al*. (2016) studied the effect of urea spray at 3 per cent at November 15th to enhance fruiting and fruit quality of mango trees cv. Fagrikalan.

Reddy and Majumdar (1983) found that yield of mango trees was increased by 88 per cent with three foliar spray of orthophosphoric acid (0.5 per cent) along with urea 2 per cent in September, November and March over the control.Baghel*et al.* (1987) observed that foliar spray of urea increased the retention of fruits of mango. Also profound effect on weight, length, diameter and volume of mango fruit was found.Tomar and Singh (2007) concluded to study the influence of foliar application of nutrients and bioregulators on walnut that highest nut (fruit) weight and kernel weight was observed under treatment of urea + paras (0.5 per cent + 0.6 ml/l) that significantly increased yield.

Effect of KNO_3 on quality

Vijayalakshmi and Srinivasan (2000) concluded that in mango cv. Alphanso, application of KNO_3 (1 per cent) greatly increased TSS from 7.67 to 14.33 per cent, total sugar from 9.25 to 12.71 per cent, sugar/acid ratio from 27.96 to 43.58 and also deceased acidity from 0.33 to 0.29 per cent.Dutta (2004) indicated that spraying of potassium increase the fruit weight and length of guava fruit.Babul and Rahim (2013) evaluate that plants treated with KNO*f* at 4 per cent and noted the highest number of fruits per plant (136.67) compared to control (62.67) and urea at 4 per cent resulted in the biggest fruit (202.83g) and KNO_3 at 4 per cent gave maximum yield (23.14 kg/plant) as compared to minimum yield (9.12 kg/plant) in the control (water spray).Patel *et al.* (2016) conducted the experiment on foliar application of nutrients and thiourea to determine the effect on yield and quality of mango cv. Kesar that 1 per cent KNO_3 in mid-October increase the number of fruits per tree, yield per tree and also improved quality parameters of Kesar mango.

Effect of ethrel on quality

Shyamal*et al*. (2010) studied the plant growth substances on vegetative growth, flowering and fruit quality of papaya and revealed that TIBA (100 and 150 ppm) and ethrel (200 and 300 ppm) were found to be the best for improving the quality of fruit.

Effect of urea on quality

Patel and Patel (1987) claimed that increase in T.S.S., total sugar and decreased acidity per cent in banana with 4 per cent urea spray.Yadav (1987) reported increased pulp content of guava with 4 per cent urea spray as compared to control.Rajput and Singh (1989) suggested that when mature 'Dashehari' mango trees were sprayed twice with urea (0, 3 and 6 per cent) before bloom, the total solids, sugars (reducing and non-reducing) and ascorbic acid were increased especially at 6 per cent. However, acidity in fruits was lowered.Singh *et al.* (1989) reported that 2 and 4 per cent urea spray increased the pulp content in Allahabad Safeda Guava.Sharma *et al.* (1990b) observed that the foliar application of urea 4 per cent increased the T.S.S., sugar, total sugar, pulp percentage and ascorbic acid contents in Langra mango, but decreased acidity per cent as compared to control. Brahmachari *et al.* (1997) observed that foliar feeding of urea at 2 per cent improved TSS., reducing sugar, non- reducing sugar, total sugar and ascorbic acid content but reduced the percentage of acidity in guava.Jain (2006) reported that application of urea singly or in combination with biozyme had shown significant increase in the total soluble solids (TSS).

CONCLUSION

In tropical and subtropical regions, the area under fruit production is increasing day by day, but due to irregular or erratic flowering, low fruit set as well as fruit retention leading to low yield and fruits of poor quality and short availability period are also the main problems in mango production. Foliar application of KNO_3, Ethrel and urea significantly improves the fruit characters, yield and quality parameters of the fruits. Ethrel release ethylene gas and turn triggering the mechanism of flowering. In addition, urea spray was reported to be helpful for better retention of flowering in certain crops. Due to spray of certain chemicals like KNO_3, Ethrel and urea early flowering can be achieved and final fruit retention is increased which leads tree towards the increase in yield and improvement in fruit characters along with quality parameters.

LITERATURE CITED

Ahmad, M. F.; Shankar, G. and Sharma, R. R. 1998. Effect of different concentrations of ureaon reproductive and physiological parameters on guava. *Annals of Agriculture Research*, **19**: 199-201.

Amarcholi, J. J.; Singh, V.; Sharma, K. M.; Patel, R. J.; Chaudhari, G. V. and Momin, S. K. 2016. Influence of various chemicals on flowering and fruiting characteristics of 'Kesar' Mango. *Research Journal of Agricultural Science,***7**(1): 53-54.

Amro, S. M. S.; Abdel-hameed, A. A. and Gammal, O. H. M. E. 2016. Effect of gibberellin and Urea foliar spray on blooming, fruiting and fruit quality of mango trees cv. Fagri Kalan. *IOSR Journal of Agriculture and Veterinary Science*, **9**(3): 9-19.

Babul, C. S. and Rahim, M. A. 2013. Yield and quality of mango (*Mangifera indica* L.) as influenced by foliar application of potassium nitrate and urea. *Bangladesh Journal Agriculture Research*, **38**(1): 145-154.

Baghel, B. S.; Sharma, R. K. and Nair, P. K. R. 1987. Influence of pre-flowering spray of urea and NAA on fruit retention of mango (*Mangifera indica* L.). *Progresive Horticulture*, **19**: 200-202.

Brahmachari, V. S.; Mandal, A. K.; Kumar, R. and Rani, R. 1995. Effect of growth substance on fruit set and physico-chemical characteristics of 'sardar' guava (*Pisidiumguajava*L.). *Recent Horticulture,***2**(2): 127-131.

Brahmachari, V. S.; Kumar, N. and Kumar, R. 1997. Effect of foliar feeding of calcium, potassium and growth substances on yield and quality of guava (*Pisidiumguajava*L.). *Haryana Journal of Horticulture Science*, **26** (3-4): 196-173.

Chandra, A. 1988. Note on control of pre-harvest fruit drop in mango. *Current Agriculture*, **12**: 91-92.

Dutta, P. 2004. A short note on foliar potassium spray in improving the quality of Sardar guava (*Pisidiumguajava*L.), *The Orissa Journal of Horticulture*, **32**(1): 103-104.

Gupta, R. K. and Brahmachari, V. S. 2004. Effect of foliar application of urea, potassium nitrate and NAA on fruit retention, yield and quality of mango cv. Bombai. *TheOrissa Journal of Horticulture*, **32**(2): 7-9.

Hafle, O. M.; Delfino, F. I.; Mendonca, V. and Araujo, N. S. E. 2003. Flowering and production of mango cv. Tommy Atkins using ethrel, potassium nitrate and calcium nitrate. *Revista De CienciasAgrarias*, **3**: 145-152.

Jain, P. K. 2006. Fruit drop, yield and quality of mango as influenced by biozyme and urea sprays. *Indian Journal of Horticulture*, **63**(4): 453-454.

Nunez, E. R. 1985. Flowering and fruit set of monoembryonic and polyembryonic mango as influenced by potassium nitrate sprays and shoots decapitation. *Proc. Fla. State Horticulture Soc.*, **98**: 179-183.

Oosthuyse, S. A. 1991. Stages of development of the mango panicle. South American Mango Grower's Association Yearbook, **11**: 59-63.

Oosthuyse, S. A. 1997. Effect of KNO_3 sprays to flowering mango trees on fruit retention, fruit size, tree yield and fruit quality. *Acta Horticulture,* **455**: 359-366.

Pandey, R. M.; Singh, R. N. and Singh, G. C. 1973. Usefulness of ethrel in regulating a flower bearing in mango. *Science and Culture*, **39**(3): 148-150.

Patel, A. H.; Tandel, Y. N.; Bhatt, A. H.; Parmar, A. B. and Patel B. A. 2016. Effect of nutrients and Thiourea on yield and quality of mango cv. Kesar. *Advance in Life Science*, **5**(2): 490-492.

Patel, R. L. and Patel, B. M. 1987. Effect of foliar spray of urea on maturity, yield and quality of banana. *South Indian Horticulture*, **35**(6): 398-402.

Patoliya, R. M.; Tandel, B. M.; Unnati, A.; Patil, S. J. and Hiralal, C. 2017. Response of foliar spray of different chemicals on yield and quality of Dashehari mango under ultra-high density plantation. *International Journal of Chemical Studies*, **5**(4): 1495-1497.

Rajput, C. B. S. and Singh, J. N. 1989. Effect of urea and GA_3 sprays on the growth, flowering and fruiting characteristics of mango. *Acta Horticulture*, **231**: 301-305.

Rajput, C. B. S. and Tiwari, J. P. 1975. Effect of foliar spray of urea on flowering and fruiting characters of three cultivars of mango. *Bangladesh Horticulture*, **3**: 1-5.

Reddy, S. E. and Majumdar, A. M. 1983. Response of mango (*Mangifera indica* L.) to foliar application of phosphorus. *Fertil Research Journal*, **4**: 281-285.

Sanyal, D.; Biswas, B. and Mitra, S. K.1996. Studies on irregular bearing of mango (*Mangifera indica* L.) effect of chemicals. *South Indian Horticulture,* **44**: 1-4.

Sergent, E.; Ferrari, D. and Leal, F. 1997.Effect of potassium nitrate and peclobutrazol on flowering induction and yield of mango (*Mangifera indica* L.) cv. Haden. *Acta Horticulture,***455**: 180-187.

Sharma, T. R.; Nair, P. K. R. and Neema, M. K. 1990a. Influence of foliar sprays of urea, KNO*f* and NAA on physical composition of mango cv. Langra. *Punjab Horticulture Journal*, **30**(1-4): 47-52.

Sharma, T. R.; Nair, P. K. R. and Neema, M. K. 1990b. Influence of foliar sprays of urea, KNO*f* and NAA on chemical composition of mango cv. Langra. *Punjab Horticulture Journal*, **30**(1-4): 53-56.

Shawky, I.; Zindan, Z.; Tomi, A. E. and Dahsan, D. 1978. Effect of urea sprays on time of blooming, flowering, malformation and productivity of Taimur mango tree. *Egyptian Journal of Horticulture*, **5**(2): 133-142.

Shyamal, M. M.; Bordoloi, B. and Pakkiyanathan, K. 2010. Influence

of plant growth substances on vegetative growth, flowering, fruiting and fruit quality of papaya. *Indian Journal of Horticulture*, **67**(2): 173-176.

Singh, G.; Rao, O. P. and Mishra, J. S. 1989. Chemical defoliation of guava with urea and NAA in guava. *Progressive Horticulture,* **21**(1-2): 49-50.

Singh, S. and Ahlawat, V. P. 1996. Effect of foliar application of urea and zinc sulphate on yield parameters of Ber (*Zizyphusmauritiana*L.) cv. Umran. *Haryana Journal Horticulture Science*, **25**(2): 33-35.

Singh, U. R. and Tripathi, J. S. 1978. Effect of foliar spray of KNO_3 and Sodium dihydrogen and the phosphorus on physioco–chemical quality of mango fruit. *Punjab Horticulture Journal*, **18:** 39-40.

Stephen, M.; Ambuko, J.; Hutchinson, M. and Owino, W. 2017. Off-season flower induction in mango fruits using ethephon and potassium nitrate. *Journal of Agricultural Science*, **9**(9): 158-167.

Sudha, R.; Balamohan, T. N. and Soorianthasundaram, K. 2012. Effect of foliar spray of nitrogenous chemicals on flowering, fruit set and yield in mango (*Mangifera indica* L.) cv. Alphonso. *Journal of Horticulture Science*, **7**(2): 190-193.

Tomar, C. S. and Singh, N. 2007. Effect of foliar application of nutrients and bio-regulators on growth, fruit set, yield and nut quality of walnut. *Indian Journal of Horticulture,* **64**(3): 271-273.

Vijayalakshmi, D. and Srinivasan, P. S. 2000. Improving the quality attributes of 'off' year Alphonso mango through chemicals and growth regulators. *Orissa Journal of Horticulture,* **28**: 31-33.

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Impact of Different Preservative Solutions on Extending Vase Life of Rose (*Rosa hybrid*) Cut Flowers

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ABSTRACT

The experiment was conducted to assess the vase life of rose cut flowers in Eritrea through the use of preservative solutions so as to make advancements in the floricultural industry. The experimental design used was completely randomized design. The treatments were Lone water (control), sucrose (5%), citric acid (CA) (300 PPM), combination of sucrose (5%) + citric acid (CA) (300 PPM); combination of sucrose (5%)+citric acid (CA) (300 PPM) with various concentrations (100,200,300ppm) of 8-hydroxyquinoline (8-HQ) and Aluminum sulphate. Change in fresh weight, bent neck, leaf wilt and drop, petal wilt and drop, flower opening and flower diameter, water uptake and vase life were recorded. There was a significant difference among the holding solutions in % of bent neck, % of leaf wilt and drop, % of petal wilt and drop, change in fresh weight, solution uptake and flower vase life. It was observed that a significant different starting from day-8 onwards in both flower diameter and percentage of flower opening. The results demonstrated that the flowers which were treated with 8-hydroxyquinoline of 200ppm combined with 5% of sucrose and 300ppm of citric acid experienced the highest vase life of cut flowers (25 days) which was found to be significantly superior as compared to the control recording a vase life of 11 days, by acting as an antimicrobial agent, increasing water uptake, lowering pH and improving the carbohydrate supply.

Key words *Aluminum sulphate, Citric acid, 8-Hydroxyquinoline, Postharvest, Rose, Sucrose, Vase life.*

Rose (*Rosa* spp.), queen of flowers is a woody perennial belongs to the family of *Rosaceae*. It is a shrub plant and has more than hundreds of species and over 2000 cultivars (Kim et al., 2003). Despite roses being used as cut flowers, are best known as ornamental plants grown for their flowers in the garden in nurseries or sometimes indoors. Majority of ornamental roses are hybrids that were bred for their flowers and they vary in size and shape and are usually large and showy with colors ranging from white, yellow and reds. According to Britannica, 2007, generally there are over 100 species and most of the species are native to Asia, with smaller numbers native to Europe, North America and northwest Africa (Table 1).

Table 1. Rose cut flower producing nations and the areas devoted for its cultivation

Country	Area of production in hectares		
	2001	2002	2003
Ecuador	1976	2012	2012
Colombia	1400	1750	1950
Kenya	-	1380	1530
Netherlands	921	907	880
Zimbabwe	500	600	350
Morocco	-	-	384
Zambia	300	120	145
Israel	210	170	-
Uganda	100	180	-
Ethiopia	-	-	32

Source: Weerts, 2002 and Haines, 1993

Africa accounts for 85 percent of imported roses, while Kenya and Ethiopia are the main suppliers. The import price of African roses was 10 euro cents in 2013 (Figure 1).

Roses are highly valuable for economic benefits being the best source of raw materials to be used in agro-based industries especially in the cosmetics and perfumery. In addition to this roses play a vital role in the manufacturing of various products of foods and medicines advancing the fields of medicine and dietary. Roses are used in making pot-pourri, rose-vinegar, rose petal-wine, jams, jellies and syrups in countries like Europe, Bulgaria. In Czechoslovakia, fruits of wild roses are used for preparing a hot drink like tea and a popular wine. Thus the various ways in which rose can be used for large scale and small scale productions are: cut flower, garden display, pot plants, perfume and allied products, source of vitamins.

In Eritrea, the area of floriculture is not yet exploited although there is a very small land (about 8.2ha) devoted for rose cut flower production around the capital city (Asmara) Maisirwa, which was established in 2009 for export and domestic utilization. The major problem of the rose cut flower production is the postharvest loss where the cut roses remain alive for a short period due to rapid transpirational and respirational losses. It is clear that unless they are preserved the ultimate fate of such produce is senescence and/or death. However it is possible to extend the postharvest life of flowers by using different

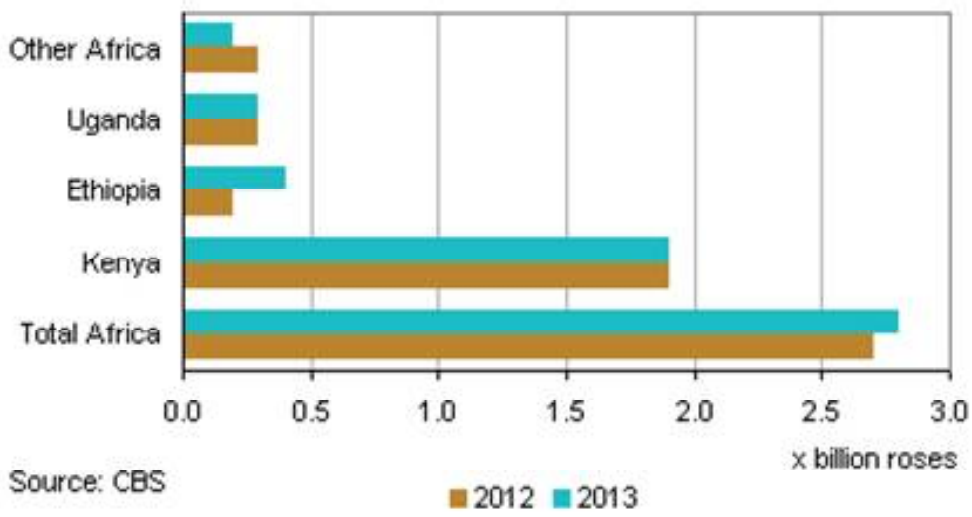

Fig. 1. Imports of roses grown in Africa (Source: CBS, 2018)

preservative solutions such as Aluminium sulfate, sucrose, citric acid, 8-hydroxyquinoline and water. Aluminium sulfate is a widely used industrial chemical and can exist with varying proportions of water, the common form being $Al_2(SO_4)_3 \cdot 18H_2O$ which is used as biocide, acidifying agent and preservative in postharvest treatment of cut flowers (Larson, 1992). Sucrose is included as a main food source in most preservative formulations whereas water is used to prevent dehydration of the cut flowers and also as a solvent for dissolving the preservative chemicals. It is wise to use water from which salts have been removed by passing it through a column or with the use of reverse osmosis equipment; the resulting water is known as deionized water, for example, rain water that is relatively clean is also useful (Schmidt, 2005). Citric acid is the most widely used to decrease the pH thereby increase vessel wall porosity, by breaking the calcium pectate bonds of vessel walls. Citric acid prevents plugging of vascular bundles, improves the water balance and enhances the intensity of petal color by changing the pH of cell sap (Parups and Molinar, 1974; Asean, 1975 and Durkin, 1979). It is , therefore, the experiment was conducted with the objectives of to rectify the problem of short vase life of the rose cut flower production process by testing different preservative solutions and ultimately it is recommended a specific preservative solution that result in to the highest vase life period of the cut roses.

MATERIALS AND METHODS

Site location

The cut flowers of *Rosa hybrid* (top secret) cultivar were collected from Maisirwa rose flower site which is located 13 km North West from Asmara, at 15° 23' North latitude and 38° 54' East longitudes and an elevation of 2300 meter above sea level. The annual rainfall of the area ranges from 400mm to 600mm and annual mean of maximum and minimum temperature are 4.3°C to 25.5°C (Ministry of Agriculture, 2015). The experiment was conducted in National Animal Health and Plant Health Laboratory (NAHPHL) Vilago, Asmara at the room temperature and a relative humidity of 22°C and 48% respectively.

Experimental design

Different preservatives imported used for the experiment were water, Aluminum sulphate, citric acid, sucrose and 8-hydroxyquinoline, as holding solutions. The experiment was carried out through the use of a completely randomized design (CRD) with ten treatments by three replications. The total experimental units were 30 including the control (Lone water as preservative solvent/solution). The treatments employed in the experiment mentioned in table 2.

Table 2. Treatments Employed in the Experiment

Treatments	
Water 1lt.	T1
Sucrose 5%	T2
Citric Acid	T3
Sucrose 5% + Citric Acid 300ppm	T4
Alum 100ppm + Sucrose 5% + Citric Acid 300ppm	T5
Alum 200ppm + Sucrose 5% + Citric Acid 300ppm	T6
Alum 300ppm + Sucrose 5% + Citric Acid 300ppm	T7
8-HQ 100ppm + Sucrose 5% + Citric Acid 300ppm	T8
8-HQ 200ppm+ Sucrose 5% + Citric Acid 300ppm	T9
8-HQ 300ppm + Sucrose 5% + Citric Acid 300ppm	T10

The harvesting was done early in the morning around 8:30 am to maintain turgidity of the cut roses. The stems were cut into slant to manage the length of the stem to be 50cm and all of them were immediately inserted into water to avoid air embolism. Finally the cut roses were re-cut making a length of 40 cm cut flowers and they were dipped

in to the respective preservatives for undertaking the experiment.

Data Collection

Change in fresh weight: Since flowers change their weight with time due to being exposed to the existing environmental conditions leading to the evacuation of water from its tissues, the change that occurred was measured by weighing the flowers before dipping them in to the solution and at the end of their vase life.

Percentage of flowers with bent necks: Flowers whose necks have started to bend due to decreased turgidity that have lost their osmotic potential were recorded on the due time (Figure 2A).

Percentage of leaf wilt and drop: Leaves start to wilt and drop when they become dehydrated as a result they change in their color from green to yellow or dark brown. Data were recorded when the leaves wilted and dropped, and it was expressed in terms of percentage (Figure 2B).

Percentage of petal wilt and drop: When the petals started to wilt they change their color from red to dark red reaching almost black and lose their aesthetic value. The data was recorded when the petals wilted and dropped, and it was expressed in terms of percentage (Figure 2C).

Percentage of flowers opening: Flowers whose pistil becomes visible were recorded every 24 hours (Figure 2D).

Flower diameter: During maturation the flower head increase in size hence, the diameter also increases. Flower diameter was measured using a ruler, expressed in terms of centimeter. This process was repeated every day until the flowers died.

Solution and water uptake: The uptake of the solution and the mere water by the cut flowers was recorded by measuring the change in volume of the lone water and the respective solutions, by subtracting the volume left at the end from the initial volume.

Flower vase life: Vase life was recorded as the number of days after harvest in which flowers reached the end of their longevity due to bent neck, leaf wilt and drop and petal wilt and drop as this indicates they have lost their aesthetic value and lose their market demand.

Data Analysis

The data collected on various parameters was analyzed using Genestat software, through analysis of variance (ANOVA) and the mean comparison was done using LSD at 5% level of significance.

RESULTS AND DISCUSSION

Change in fresh weight

Change in fresh weight of the cut flowers was found to be significantly influenced by the different preservative solutions with T2 recording the least value 4.24g followed by treatments T1 and T4 each recording 4.41g and 5.76g

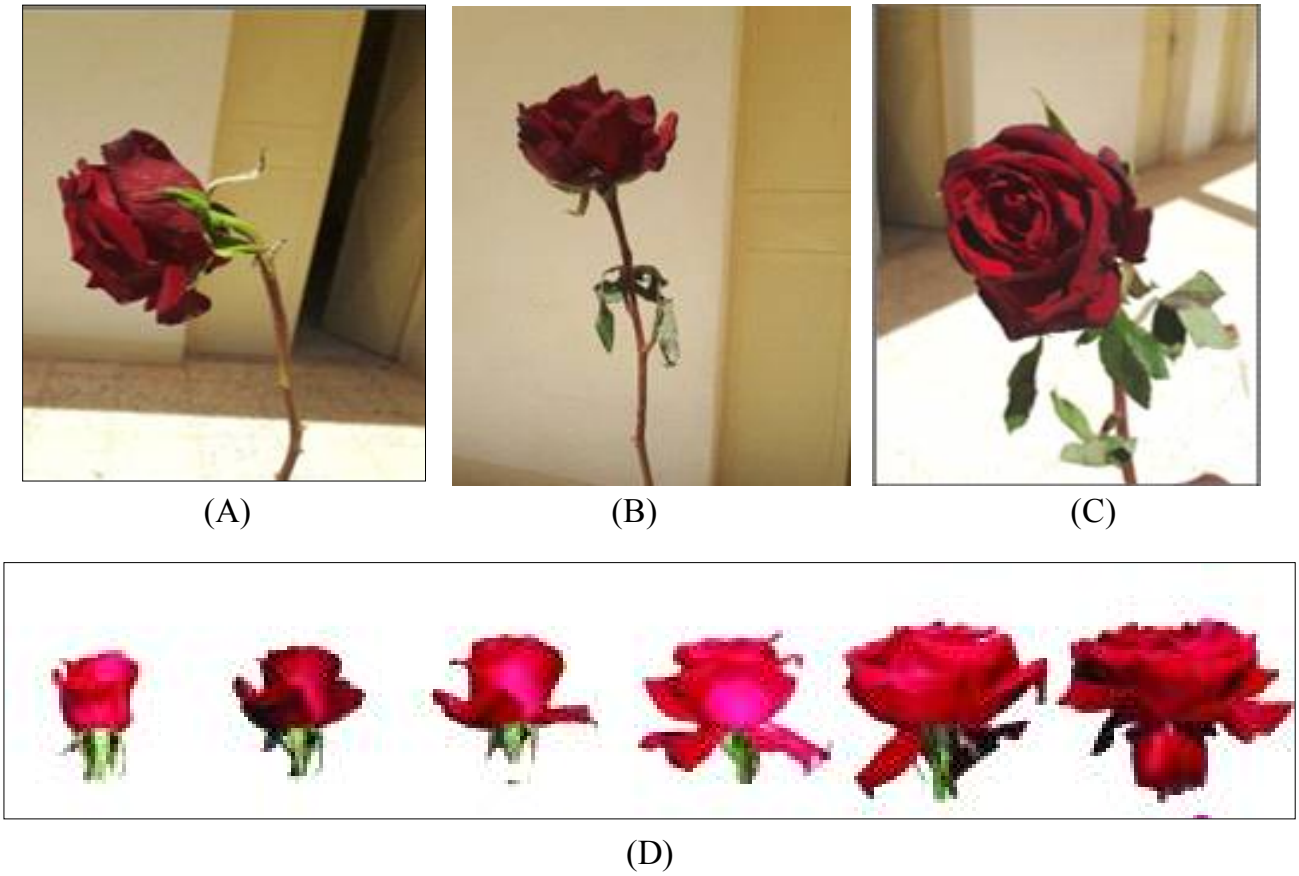

Fig. 2. Bent neck due to decreased turgidity (A); leaf wilt when they become dehydrated (B); Petal wilt changes their color from red to dark red reaching almost black (C) and Pistil visible or Flower opening (D).

respectively, whereas the highest value of change in fresh weight was recorded in T3 attaining a value of 9.88g.

Treatment T2 which was seen to be the best one in terms of preserving the water content of the cut flower was found to be significantly superior as compared to all other treatments except with T1 and T4. This is due to the fact that sucrose as lone food source getting trans-located and accumulated in the flowers, increase their osmotic concentration, and improving their ability to absorb water and maintain their turgidity. The outcome of this experiment was found to be at par with the findings of Reddy and Singh (1996) who have explained that sucrose increase the water uptake and maintain a better water balance and a higher fresh weight for longer periods.

Percentage of bent neck

A significant difference in the percent experiment of bent neck was recorded among the preservative solutions. The treatments T5 and T9 equally recorded the least value (0%) of bent neck followed by treatments T3 and T8 both of them recording 20% of bent neck, whereas the highest percent of flower whose necks were bent was recorded in treatment T1 attaining a value of 66.7%. Treatments T5 and T9 were found to be significantly superior as compared to all other treatments except with treatments T3 and T8 (Table 3).

The least value of bent neck recorded in treatments T5 and T9 is mainly due to the ability of the chemical treatments (Aluminum sulphate and 8-hydroxyquinoline) maintaining the water potential and increase the turgidity of the flower necks by maintaining the osmotic potential. The result of this experiment was found to be in agreement with the findings of Kim and Lee (2002) who also found that the preservative solution containing sucrose and 200 ppm 8-HQS extended vase life and inhibited flower senescence and bent neck in rose cut flowers.

Percentage of leaf wilt and drop

A significant variation was observed in the percent of leaf wilt and drop among the preservative solutions. The least value (40%) was recorded from treatments T2 and T5 which were found to be significantly different as compared to all other treatments except with treatment T8. The least percent of leaf wilt and drop recorded in treatments T2 and T5 could be mainly due to the effect spraying Aluminum sulphate solution on the closure of stomata that results into reduced transpiration rate where treated blooms remained fresh for 10-14 days whereas untreated blooms wilted within 2 days (Schnab, 1976). Besides this, since water as a treatment doesn't supply food to the cut flower, the cut flowers kept on the mere water resulted in to the highest percentage of leaf wilt and drop.

Water is continually being lost in cut flowers through transpiration and decreased water conductance in the stem, resulting in the premature wilting of both flowers and leaves, making them unacceptable to consumers (Teixeira da Silva, 2003).

Percentage of petal wilt and drop

A significant effect of the preservative solutions was observed in percentage of petal wilt and drop. Treatment T3 recorded the least value 26.7% and was found to be significantly superior as compared to all other treatments with a maximum discrepancy value of 73.3%.

The decrease in the value of this parameter could be due to the impact of citric acid in preventing the plugging of vascular bundles, improving the water balance and enhancing the intensity of petal color by changing the pH of the cell sap (Parups and Molinar, 1974; Asean, 1975; Durkin, 1979).

Solution uptake (ml)

A highly significant difference was experienced in the solution uptake of the cut flowers among the preservative solutions. The treatment T9 was recorded the highest value (406.7ml) and it was followed by T8 recording a value of 400 ml, whereas the lowest value of solution uptake was recorded in treatment T1 experiencing a value of 213.3ml. It was observed that, T9 being the best one, was found to be significantly superior as compared to all other treatments except with T8.

The increased amount of solution uptake which was recorded by the T9 could be due to the fact that, 8-HQ acting as an antimicrobial agent and has also the capacity to increase water uptake (Ketsa et al., 1995) and (Reddy et al., 1995). Thus in agreement with the findings of this experiment (Ketsa et al., 1995) and (Reddy et al., 1995) reported the advanced effect of Hydroxy-quinoline in its uptake by the rose cut flowers.

The lowest value of solution uptake was recorded in T1 and it could be due to vascular blockage. The lowest water uptake recorded in this experiment was found to be at par with findings of (Teixeira da Silva, 2003 and Schmidt, 2005) who have reported similar results pertaining to water uptake by the rose cut flowers.

Flower vase life

The flower vase life was influenced significantly by the various preservative solutions. Treatment T9 exhibited the highest value (24.33 days) of flower longevity which was followed by treatment T8 with a value of 21.33 days, whereas the lowest value of flower vase life was recorded from treatment T1 showing a value of 12.67 days. Treatment T9 was found to be significantly superior as compared to all other treatments with the maximum discrepancy value of flower vase life being 11.66 days.

Treatment T9 was found to be significantly superior as compared to all other treatments. This could be due to the fact that T9 contains a biocide, food and acidifying agent 8-HQ is more effective when sucrose was added to it (Ichimura et al., 1999). The 8-HQ markedly inhibited the growth of bacteria and fungi even with concentrations as low as 100 mg/liter (Yi Ping et al., 1997).

Treatment T1 recorded the lowest value of flower vase

Table 3. Effect of different treatments on bent neck, leaf and petal wilt and drop, change in fresh weight, solution uptake and flower vase life.

Treatments	% of bent neck	% of leaf wilt and drop	% of petal wilt and drop	Change in fresh weight (in g)	Solution uptake (in ml)	Flower vase life (in days)
T1	66.7	100	100	4.41	213.3	12.67
T2	53.3	40	80	4.24	246.7	17.33
T3	20	80	26.7	9.88	265	15
T4	40	60	93.3	5.76	238.3	17
T5	0	40	100	6.82	236.7	15.65
T6	33.3	73.3	100	7.45	228.3	17
T7	33.3	66.7	100	8.79	245	16.65
T8	20	46.7	100	9.29	400	21.33
T9	0	73.3	86.7	8.32	406.7	24.33
T10	53.3	73.3	86.7	7.44	306.7	19.67
L.S.D	27.81	27.81	16.45	2.153	64.14	1.555
CV%	51	25	11.1	17.5	13.5	5.2

life and this could be because lone water cannot act as food, biocide, acidifying agent and thus it is not effective in extending the vase life (Cho and Lee, 1979). The result obtained by Knee (2000) and Hassan (2005) who found that the vase life of cut roses as well as gain of fresh weight significantly improved by using 8-HQ, is supportive to this study. Maitra et al. (2001) studied the effect of preservative chemicals on postharvest behavior of cut rose where cut flowers treated with 8-HQ along with 4% sucrose resulted in extended vase life and enhanced the fresh weight in comparison with the control. The preservative solution containing 3% sucrose and 200 ppm 8-HQ extended vase life and inhibited flower senescence and bent neck in rose cut flowers (Kim and Lee, 2002).

Percentage of Flower opening

As the effect of different preservatives on the flower opening was observed, there was no significant difference between the treatments in day-1 and day-8. The effect of holding solutions on percent of flower opening showed highly significant variations ($p<0.01$) in day-16 with the maximum value of flower opening (90.2%) being recorded from T8 followed by T10 and T9 each recording 87.1% and 86.2% respectively. Whereas the least value of flower

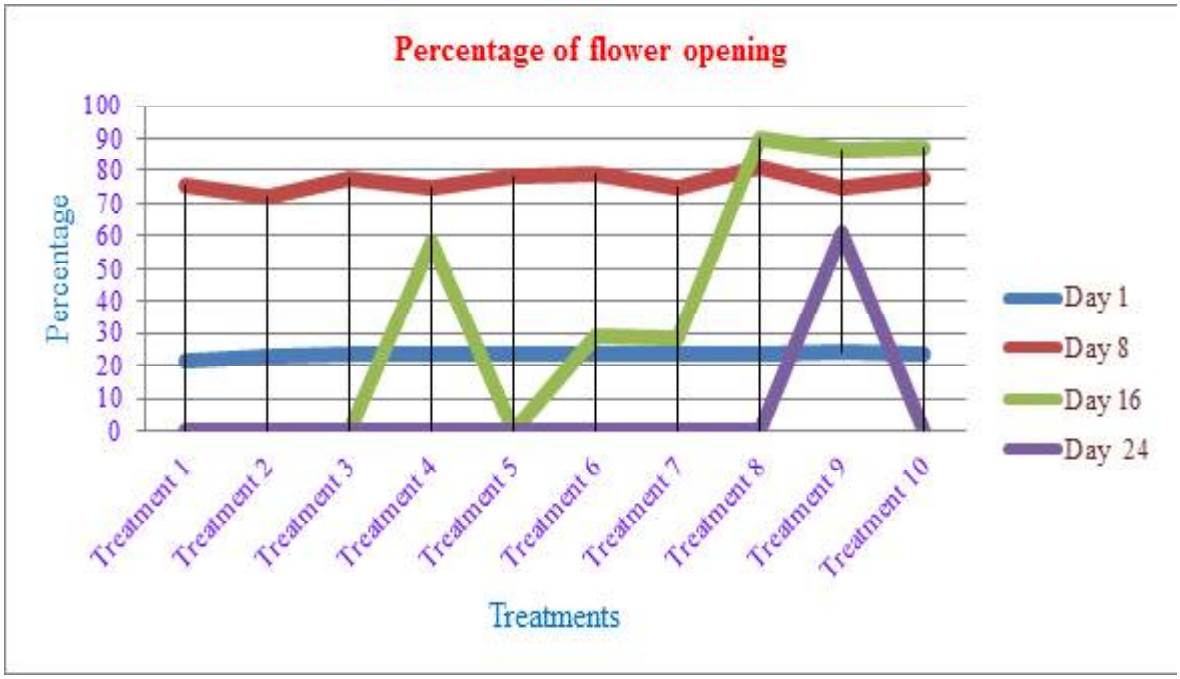

Fig. 3. Percentage of Flower opening as affected by different holding solutions (treatments) in different periods (from day-1 until day-24)

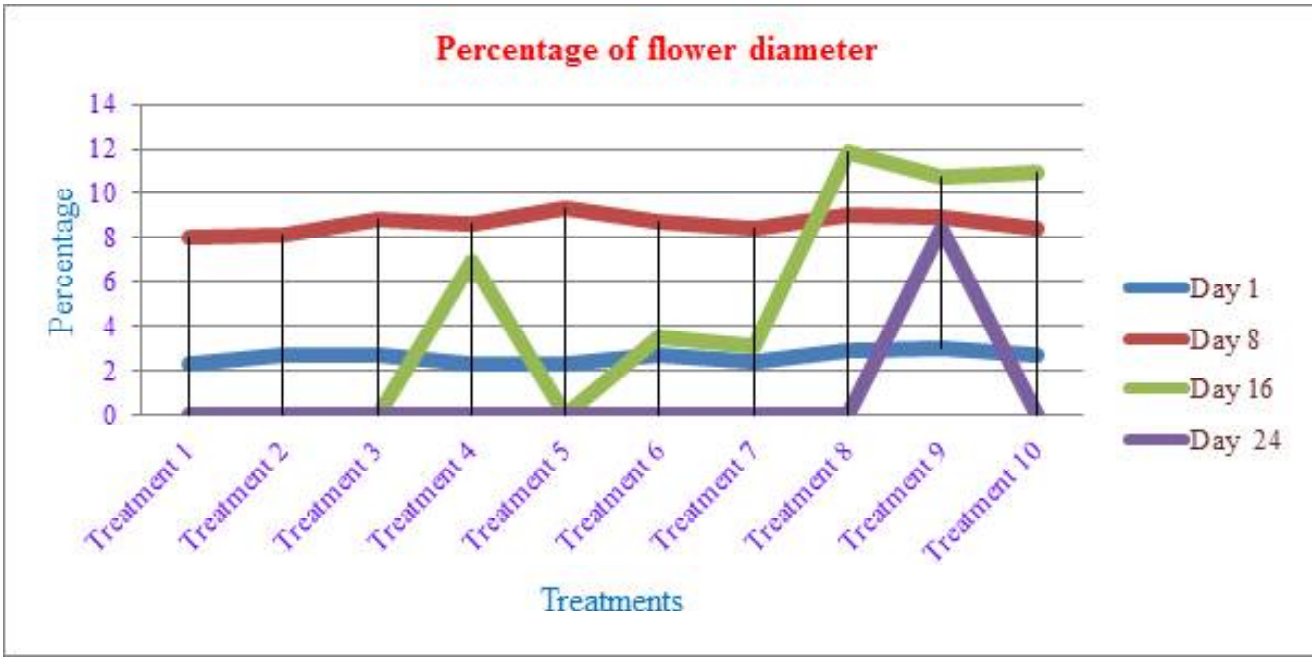

Fig. 4. Percentage of Flower diameters as affected by different holding solutions (treatments) in different periods (from day-1 until day-24)

opening (0%) was recorded in T1, T2, T3 and T5. In day-24 there was significant difference ($p<0.05$) between the treatments with T9 showing the maximum value of flower opening (60.7%) and it was seen to be significantly superior as compared to all others.

Flower diameter

As the effect of different preservatives on the flower diameter was observed, there was no significant difference between the treatments in day-1 and day-8. The effect of preservative solutions on flower diameter showed highly significant variations ($p<0.01$) in day-16, Maximum flower diameter (11.90cm) was recorded in T8 followed by (10.97cm and 10.77cm) in T10 and T9 respectively. On the other hand minimum flower diameter (0 cm) was recorded in T1, T2, T3 and T5. In day-24 there was significant difference ($p<0.05$) between the treatments with T9 recording the significantly highest value of flower diameter (8.45cm) when compared to the other treatments.

CONCLUSIONS

Based on the above results obtained from statistically analyzed data the treatments like vase life, change in fresh weight, leaf wilt and drop, percentage of bent neck, petal wilt and drop as well as solution uptake of the cut flowers were found to be significantly influenced by the various preservative solutions. The preservative solution 200ppm 8-HQ + 300ppm CA+ 5% sucrose was found to be the best treatment which has significantly increased the vase life of cut rose flowers, and the lowest flower vase life was observed in flowers treated with water.

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LITERATURE CITED

Asean, S. 1975. Factors affecting the flower colour. *Acta Horiculture*. 41: 57-68.

CBS (Central Bureau voor de Statistiek (NL), 2018. https://www.cbs.nl/en-gb/news/2015/07/2-8-billion-roses-imported-from-africa (Accessed on August, 2018).

Cho, H. K. and, J. M., Lee 1979. Studies on Extending the Life of Cut Flowers of Rose and Carnation with Various Chemical Preservative. *Journal of the Korean Society for Horticultural Science*. **20** (1): 106-110.

Durkin, D. 1979, Effect of Millipore filtration, citric acid, and sucrose on peduncle water potential of cut rose flowers. *J. Ameri. Soc. Horti. Sci*. 104: 860-863.

Haines, B. 1993. Morocco Fights for Supply Position, Floriculture International, October 1993, pp.68. http://www.biotech-monitor.nl/2004.html (Accessed on March, 2018).

Hassan, F. and Schmidt. 2004. Post Harvest Characteristics of cut carnations as the results of chemical treatments. *Acta Agronomica*. Hungarica. **52** (2): 125-132.

Ichimura, K., U., Shigefumi, and G., Rie, 1999. Possible Roles of Soluble Carbohydrate Constituents in Cut Rose Flowers. *Journal of the Japan Society for Horticultural Science*. **68**(3): 534-539.

Ketsa, S., Y., Piyasaengthong and S., Prathuangwong, 1995. Mode of Action of Silver nitrate in Maximizing Vase Life of Dendrobium Pompadour Flowers. *Postharvest Biology and Technology*. **5**: 109-117.

Kim CK, JD Chung, SO Jee and JY Oh. 2003. Somatic embryogenesis from *in vitro* grown leaf explants of *Rosa hybrida* L. *J Plant Biotechnol*. **5**:169-72.

Kim, Y., and J.S., Lee, 2002. Anatomical Difference of Neck Tissue of Cut Roses as Affected by Bent Neck and Preservative Solution. *Journal-of-the-Korean-Society-for- Horticultural-Science*. **43** (2): 221-225.

Knee, M. 2000. Selection of biocides for use in floral preservatives. *Post Harvest Biology and Technology.* **18**:227-34.

Larson, A.R. 1992. Introduction to Floriculture: Second Edition. New York: Academic Press.

Maitra S, MK Mondal and N Roychowdhury. 2001. Effect of preservative chemicals on postharvest behaviour of cut rose cv. Etoile De France. *Madras Agriculture Journal*. **88** (1-3): 97-100.

Ministry of Agriculture - MoA. 2015. Assessment of flower farms in Eritrea, Eritrea.

Parups, E. V. and J. M Molinar. 1974, Histo-chemical study of xylem blockage in cut roses. *J. Ameri. Soc. Horti. Sci*. **97**: 532-534.

Reddy, B. S., and K. Singh, 1996. Effects of Aluminium Sulphate and Sucrose on Vase Life of Tuberose. *Journal of Maharashtra Agricultural Universities*. **21**(2): 201-203.

Reddy, B.S., K. Singh, and A. Singh, 1995. Effect of Sucrose, Citric Acid and 8-Hydroxyquinoline Sulphate on the Postharvest Physiology of Tuberose Cv. Single. *Advances in Agricultural-Research-in-India.* **3**(10): 161-167.

Schmidt, J. C. 2005. Care of Cut Flowers and Foliage. Department of Horticulture, University of Illinois. http://www.nres.uiuc.edu/outreach/pubs/hfs/CutFlowerFoliage.pdf (Accessed on May, 2018).

Schnabl, H. 1976. Retaining Freshness in Cut Flowers with Aluminium. *Deutscher Gartenbau*. **30**(26): 859-860.

Teixeira da Silva, T.J.A. 2003. The Cut Flower: Postharvest Considerations: Asian Network for Scientific Information, Japan. *On Line Journal of Biological Sciences.* **3**(4): 406-442.

Weerts, J.A. 2002. The Effect of Sucrose-Pulsing on Cut Carnation and Freesia Flowers. Masters thesis, Botany in the Faculty of Science at the Rand Afrikaans University.

Yi Ping, X., M.C., Sheng, and E. Zhi Yi, 1997. The Activities of Microorganisms and the Physiological Effect of Germicide in Cut Rose during Postharvest Life. *Acta Horticulturae Sinica.* **24**(1): 63-66.

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In vitro Evaluation of Efficacy of Organic Amendments against *Fusarium incarnatum* (Desm.) Sacc. Causing Wilt of Crossandra (*Crossandra infundibuliformis L . Nees*)

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ABSTRACT

An *in vitro* experiment was conducted to identify the most suitable organic amendment to manage the crossandra wilt caused by *Fusarium incarnatum*. Seven most commonly available and used organic amendments were tested for their efficacy against *F. incarnatum*. All the tested organic amendments reduced mycelia growth of fungi when compared with control. But among the all, neem cake at 5 and 10 per cent concentration significantly recorded maximum (49.8 and 70.4% respectively) reduction of mycelial growth of pathogen over control and it was followed by mahua cake (5 and 10%) which recorded 46.2 and 63.8 per cent reduction of mycelial growth over control respectively. The minimum of 46.9 per cent growth reduction over control was observed in FYM (10%) extract. These studies revealed the antimicrobial activity of different organic amendments and among all organics, neem cake is the best in managing crossandra wilt pathogen.

Key words *Crossandra, Fusarium incarnatum, Neem cake, Organic amendments*

Crossandra (Fire cracker) is an important commercial flower, mainly grown in India, Tropical Africa and Madagascar (Bailey, 1963). The flowers are commonly used for hair adornment. Though not fragrant, these flowers are very popular because of their attractive bright colour, light weight and good keeping quality. The crop is frequently affected by various fungal diseases. Among the various fungal diseases wilt disease caused by *Fusarium* spp. is one of the major problem in crossandra production and limits the crop cultivation. Management of this disease has become very difficult due to its soil borne and complex nature. However, not much research work has been carried out and not much information is available regarding this disease. The overuse of chemical pesticides for disease management has caused soil pollution and harmful effects on human beings. Organic amendments enhance the availability of nutrients besides improving physical condition of soil, increase the yield and reduce the soil borne diseases (Ramarethinam and Rajagopal, 1999). Nimbidin, a neem constituent was observed to have antifungal activity against *Alternaria tenuis, Fusarium oxysporum, Helminthosporium nodulosum* and *Curvularia tuberculata* (Khan *et al*., 1974). Zaidi *et al*. (2002) reported

neem cake and neem leaves as effective amendments against *Fusarium* wilt of okra. Iqbal *et al.* (2005) observed that soil amendment with groundnut cake was effective against *Fusarium oxysporum*f.sp.*ciceri* followed by neem cake.

Taking it as an objective and keeping the importance of the disease, an attempt has been made to test different organic cakes on the phytopathogenic fungi *F. incarnatum* causing wilt of crossandra at Department of Plant Pathology, Agricultural College and Research Institute, Madurai, TNAU.

MATERIALS AND METHODS

Preparation of aqueous extracts from oil cakes

Required quantity of each oil cake was taken and made into powder separately. It was soaked in sterile distilled water @ one g in 1.25 ml of water separately and kept overnight. The material was ground using a pestle and mortar and filtered through a muslin cloth and the filtrate was centrifuged at 10,000 rpm for 15 min, and the supernatant served as the standard extract solution (100%) (Dubey and Patel, 2000).

Testing the antifungal activity of oil cake extracts against *F. incarnatum in vitro*

The efficacy of extract of oil cakes was tested against *F. incarnatum*

using poisoned food technique (Schmitz, 1930). The freshly prepared was distributed @ 50 ml PDA medium per conical flask. Aqueous extracts of each oil cake was mixed @ 2.5 and 5 ml with 50 ml of PDA medium separately to obtain 5 and 10 per cent concentrations respectively and sterilized. The sterilized PDA medium (15 ml per Petri dish) containing extracts of each oil cake was poured on sterilized Petri dish separately and then allowed to solidify. A nine mm mycelial disc of *F. incarnatum* was taken from actively growing culture and placed at the centre of each Petri dish and incubated at room temperature. The PDA medium without extract of oil cakes served as control. The radial growth (cm) of *F. incarnatum* was recorded after ten days

Table 1. Efficacy of extracts of oil cakes against the mycelial growth of *F. incarnatum in vitro*

Sl. No.	Organic amendments	5% concentration of oil cake extract		10% concentration of oil cake extract	
		Mycelial growth at 10 DAI (cm)*	Growth reduction over control (%)	Mycelial growth at 10 DAI (cm)*	Growth reduction over control (%)
1	Neem cake	4.52	49.8	2.66	70.4
2	Mahua cake	4.84	46.2	3.26	63.8
3	Gingelly cake	5.68	36.9	4.32	52.0
4	Cotton cake	5.90	34.4	3.48	61.3
5	Groundnut cake	6.4	28.9	4.40	51.1
6	FYM	5.88	34.7	4.78	46.9
7	Vermicompost	6.16	31.6	4.68	48.0
8	Control	9.0	-	9.00	-
CD (P = 0.05)		**0.15**	**-**	**0.18**	**-**
SE(m)±		**0.05**	**-**	**0.06**	**-**

* Mean of five replications DAI – Days after inoculation

of incubation. Five replications were maintained for each treatment.

RESULTS AND DISCUSSIONS

The addition of organic residues to soil was one of the effective tools for the management of soil borne diseases. In order to manage the soil borne diseases, the effect of organic amendments including oil cakes and organic amendments were studied. The experimental results showed that neem cake at 5 and 10 per cent concentration significantly recorded maximum (49.8 and 70.4% respectively) reduction of mycelial growth over control and it was followed by mahua cake (5 and 10%) which recorded 46.2 and 63.8 per cent reduction of mycelial growth over control respectively. The minimum of 46.9 per cent growth reduction over control was observed in FYM (10%) extract (Table 1).

This study confirms the earlier result reported by Zaidi *et al*. (2002) who stated neem cake and neem leaves were effective amendments against *Fusarium* wilt of okra. The oil-seed cakes of neem *(Azadirachta indica),* castor *(Ricinus communis),* linseed *(Linum usitatissimum),* groundnut *(Arachis hypogaea)* and mustard *(Brassica campestris)* were tested for their efficacy and found that neem was effective when compared to all other oil cakes (Sartaj A. Tiyagi *et al.,* 2008). Among the extracts of different organics *viz*., neem cake, mustard cake, groundnut cake, castor cake, coconut cake, poultry manure and pressmud tested against *Fusarium solani in vitro*, the least growth was recorded by the extract of neem cake with 59.8 per cent inhibitory effect (Yelmame *et al.,* 2010). Chandel, (2011) also reported that soil amended with pine leaves gave maximum reduction of *Fusarium oxysporum* f. sp. *dianthi* (82%) followed by neem cake (71%) and mustard cake (59%). Amutha, (2011) reported that *in vitro* testing of five per cent neem cake inhibited maximum mycelial growth of (70.64 %) *Fusarium* wilt pathogen of brinjal and also soil amendments of neem cake 250 kg/ha significantly reduced the wilt incidence to 78.69 per cent compared to untreated control.

The results proved that organic amendments reduced the disease incidence by directly affecting the activity of the pathogen by antibiosis or reducing the number of propagules or by increased saprophytic soil flora which might show antagonism or competition towards the pathogen (Chakrabarti and Sen, 1991).

LITERATURE CITED

Amutha, C. 2011. Ecofriendly management of brinjal (Solanum melongena L) wilt caused by *Fusarium solani* f.sp.*melongenae* (Mart.) Sacc. M.Sc. (Ag.) Thesis, Agricultural college and Research Institute, Madurai.Tamil Nadu Agric, Univ., Coimbatore, Tamil Nadu., India.

Bailey,L.H. 1963. *The standard cyclopedia of horticulture Newyork*: The Mac Millan.

Chakrabarti, S.K. and B. Sen. 1991. Suppression of *Fusarium* wilt of muskmelon. *Indian Phytopath.,* **44:** 476 – 479.

Chandel, S. 2011. Non- chemical alternatives in managing fusarium wilt of carnation caused by *F. oxysporum* f.sp. *dianthi.J. Mycol. Pl. Pathol.,* **41**:111.

Iqbal, M.S., I.K. Haq, A. Baksh, A. Ghafoorand A.M. Haqqani. 2005. Screening of chickpea genotypes for resistance against Fusariumwilt. *Mycopathol*., **3 :** 1-5.

Dubey, S.C. and B. Patel. 2000. *In vitro* evaluation of some oil cakes and plant extracts against *Thanetophorus cucumeris, Gliocladium virens* and *Trichoderma viride. J. Mycol. Pl. Pathol.,* **30** (3): 411-413.

Khan, M.W., M.M. Alam, A.M. Khanand and S.K. Saxena. 1974. Effect water soluble fraction of oil cakes and bitter principles of neem on some fungi and nematode. *Acta Bot. Indica.,* **2:** 120-128.

Ramarethinam, S. and B. Rajagopal. 1999. Efficacy of *Trichoderma* spp., organic amendments and seed dressing fungicides on rhizome rot of turmeric. *Pestology,* **13 :** 21-30.

Sartaj A. Tiyagi., M. Abdul Viqar Khanand and Mashkoor Alam. 2008. Role of oil-seed cakes for the management of plant-parasitic nematodesand soil-inhabiting fungi on lentil and mungbean, *Archives of Phytopathology and Plant Protection.,* **33:**453-472.

Schmitz, H. 1930. *Poisoned food technique Industrial and Engineering Chemistry Analyst.,* **2:** 361.

Zaidi, S. Ashraf and M.H. Dar. 2002. Effect of organic amendments *Trichoderma harzianum* and fungicides on wilt of okra caused by *Fusarium oxysporum* f.sp.*vasinfectum. Plant Dis.,* **75:** 384-490.

Yelmame, M.G., B.P. Metha, A.J. Deshmukh and V.A. Patil. 2010.Evaluation of some organic extracts *in vitro* to control *Fusarium solani* causing wilt. *Int. J. Pharma. Biosci.,* **1(2)**: 1- 4.

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Isolation, Biotyping and Serotyping of *Escherichia coli* Isolated from Fresh Water Fish

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ABSTRACT

A total 200 samples which includes skin (25), gills (25), muscles (25), intestine (25), water sample (25) as well as swabs from butchers' hand (25), knife (25) and log (25) were collected from various fish selling retail meat markets of Anand city, Gujarat. Out of 200 samples, 43 (21.5 %) *E. coli* isolates were recovered based on production of lactose fermenting pink colored colonies on MacConkey agar medium and colonies with greenish metallic sheen on EMB agar medium. All the isolates were biochemically tested for IMViC pattern and carbohydrate fermentation. Thus, all 43 *E. coli* isolates were biotyped based on carbohydrate fermentation patterns with eight sugars viz. adonitol, dulcitol, mannitol, sorbitol, raffinose, rhamnose, salicin and sucrose into 72 different combinations. The most commonly occurring biotypes were IV (42 isolates), VI (40 isolates), XXVIII (39 isolates), V (38 isolates) and III (37 isolates). All 43 isolates were sent to National Salmonella and Escherichia Center (NSEC), Central Research Institute, Kasauli. Of these 43 isolates, 17 were serotyped into nine different 'O' groups, while 22 isolates were untypable and 4 isolates were found rough. The serotypes obtained were O11, O17, O22, O35, O36, O83, O84, O88 and O149. The most predominant serotypes were O11 (three isolates), O35 (three isolates), O88 (three isolates), O83 (two isolates), O149 (two isolates) other serotypes were O17, O22, O36 and O84 (one isolate each).

Key word *E. coli, carbohydrate fermentation, Kasauli,*

Fish is an important source of proteins in human diet (Subasinghe, 2009). Fisheries sector in India has made rapid strides in recent years and has been considered as sunrise sector being a major foreign exchange earner in the Indian economy (Ayyappan, 2006). Gujarat rank fourth in freshwater fish production in India. The aquaculture in India mainly constitute Indian major carps viz., the Catla (*Catla catla*), the rohu (*Labeo rohitha*) and the mrigal (*Cirrhinus mrigala*), which contribute to over 75% percent of the total Indian aquaculture production (Reddy, 1999). Foodborne diseases are a growing public health problem worldwide. Being a highly perishable product, fish and fish products accounted for the 17% of food-borne disease outbreaks in United States (Gould, 2013). *E. coli* is considered as one of the most important food-borne pathogen in fish and fish products. *E. coli* has been widely applied as a microbiological quality parameter and as an indicator organism of faecal contamination of fish products (Costa, 2013)

Serotyping of *E. coli* occupies a central place in the study of this pathogen (Lior, 1996). Prior to the identification of specific virulence factors in *E. coli* strains, serotype analysis was the predominant means of differentiation of strains. According to modified Kauffman scheme, *E. coli* is serotyped on the basis of their O (somatic), H (flagellar) and K (capsular) antigen profiles (Edwards and Ewing, 1972; Lior, 1996). A total of 170 different O antigens, each defining a serogroup, are recognized currently. For the purpose of epidemiological investigation, serotyping of *E. coli* isolates has been widely employed.

E. coli can be classified into six pathogroups based on their virulence scheme: enterotoxigenic *E. coli* (ETEC), enteropathogenic *E. coli* (EPEC), enteroinvasive *E. coli* (EIEC), enteroaggregative *E. coli* (EAEC), enterohemorrhagic *E. coli* (EHEC), shiga toxin producing *E. coli* (STEC) (Quinn *et al.,* 2011). Enterotoxigenic *E. coli* (ETEC) which produce heat labile toxin (LT) and heat stable toxin (ST) and they inducing traveller's diarrheoa. Enterohemorrhagic *E. coli* (EHEC) which produce verotoxins or shiga-like toxin and causing haemorrhagic colitis and haemolytic uremic syndrome. Enteroinvasive *E. coli* (EIEC) is the typically invade and destroy the bowel mucosa and that can induce diarrheoa. Enteropathogenic *E. coli* (EPEC) is responsible for a persistent diarrhea in children (Nataro and Kaper, 1998). The epidemiology and pathogenicity of Enteroaggregativ *E. coli* (EAEC) strains have not yet been clearly defined, but the presence of a large 60 KD plasmid encoding several virulence factors and toxins is important for their virulence (Li and Mathias, 1982). So, keeping in view of this background information, the present investigation was undertaken for isolation, biotyping as well as serotyping of *E.coli* isolates from fresh water fish in and around Anand city, Gujarat

MATERIALS AND METHODS

Sample collection

A total of 200 samples which comprising of skin (25), gills (25), muscles (25), intestine (25), water sample (25) as well as swabs from butchers' hand (25), knife (25) and log (25) were collected from various fish selling retail meat markets of Anand city. The samples like skin, gills, intestine and muscles were collected in sterile vial under aseptic condition. Moreover, butchers' hand swab and their insrtuments' swabs (particularly log and knife) were taken in sterile swab container under aseptic condition and transported to the laboratory in an icebox for further study.

Enrichment of samples

Skin, muscle, Gills and intestine of fish were separated aseptically from the fish samples and about 10 g were inoculated in to the MacConkey broth for enrichment and incubated at 37ÚC for 18 h while swab samples were directly inoculated into requistic medium.

Table 1: Serotypes isolated from different samples

Types of Sample	Total no. of isolates	No. of serotypes isolated based on "O" antigen	Percentage of serotypes (%)	Different serotype detected
Skin	4	1	25	O149(1), UT(3)
Gills	6	3	50	O11(1), O35(2), UT(2), R(1)
Muscle	2	1	50	O149(1), R(1)
Intestine	10	6	60	17(1), 35(1), 36(1), O83(1), O88(2), UT(4)
Water	13	3	23.07	O83(1), O84(1), O88(1), UT(9), R(1),
Butchers' hand swab	2	1	50	O11(1), UT(1)
Knife swab	1	0	00	UT(1)
Log swab	5	2	40	O11(1), O22(1), UT(3), R(1)

Isolation and identification

Primary isolation of *E.coli* was carried out by streaking enrichment sample on MacConkey agar by using sterile platinum loop. Cultured plate was incubated at 37ÚC for 24 hours. The lactose fermenting colonies was identified and further inoculated on Eosin methylene blue (EMB) agar. The plate was incubated for 37ÚC for 24 hours and observed for greenish metallic sheen of colonies. All samples were subcultured on Nutrient agar slant for the further study.

Biotyping of *E. coli* isolates

Biochemical reactions have conventionally been used for identification of bacteria to the species level. Extensive studies of biochemical reactions of bacteria have been done to introduce biochemical typing systems in epidemiological studies of bacteria (Barr and Hogg, 1979; Krishnan *et al.*, 1987). *E. coli* are able to ferment variety of carbohydrate substrates, generally by converting them to glucose or to a substrate on the fermentative chain of the breakdown of glucose.

Carbohydrate fermentation test was performed to detect production of acid and gas from adonitol, dulcitol, raffinose, rhamnose, sorbitol, sucrose, mannitol, and salicin by inoculating isolates into 1% (w/v) Andrade peptone water with inverted Durham tubes. The tubes were incubated at 37°C for seven days and reading were recorded after every 24 hours. The colour change in the tubes to pink was taken as positive for fermentation and presence of bubbles in Durham tube was considered positive for gas production.

Serotyping of *E. coli* isolates

Serotyping of isolates on the basis of their 'O' antigen was done at National *Salmonella* and *Escherichia coli* Centre (NSEC), Central Research Institute (CRI), Kasauli, Himachal Pradesh, India.

RESULTS AND DISCUSSION

Out of 200 samples, 43 (21.5 %) samples were found positive for *E. coli*. Highest prevalence of *E. coli* was recovered from water samples (52%) followed by intestine (44 %), gills (24%), log swab (24%), skin (16%), muscle (8%), butchers' hand swab (8%) and knife swab (4%).

In the present study 22.50 per cent isolates revealed characteristic features of *E. coli* from fish which is in agreement with the earlier findings; 13 per cent by Sharma *et al*. (2006), 23 per cent by Hansen *et al*. (2008), 23.2 per cent by Yagoub (2009), 20 per cent by Eze *et al*. (2011), 13.06 per cent by Musefiu *et al*. (2011), 24.28 per cent by Purushottam *et al*. (2011). Earlier studies indicated lower prevalence of *E. coli* in fresh water fish as 5 per cent by Mohamed *et al*. (2011), 7 per cent by Singh and Kulshretha (1994) and nine per cent by Adesiyun (1993) which is indicative of good hygienic practices prevailing in the area covered under previous studies. In contrast to the present findings, Sifuna *et al*. (2008) found all 60 fish samples (100%) studied by them were found contaminated with *E. coli*. Also higher rate of prevalence of *E. coli* was reported as 29.34 per cent by Gupta *et al.* (2013) and 60 per cent by Ameer (2016). This might be due to heavy contamination of the fish habitat. In the present study 16 per cent of prevalence was found in skin which was lower than the prevalence reported by Barbosa *et al.* (2014) who recovered 27.08 per cent isolates from fresh water skin samples. In the present study 24 per cent of prevalence was found in gills which was lower than the prevalence reported by Barbosa *et al.* (2014) who recovered 56.82 per cent *E. coli* isolates from gills. Prevalence of *E. coli* in muscle was found 8 per cent in present study, the similar result, 9.09 per cent was reported by Rocha *et al.* (2014). Also lower prevalence 5.20 per cent in muscle was reported by Barbosa *et al.* (2014).

All the 43 *E. coli* isolates were studied for the sugar fermentation activity of the following sugar viz. adonitol, dulcitol, mannitol, sorbitol, raffinose, rhamnose, salicin and sucrose. All isolates showed the ability to utilize one or more sugars. Thus, all 43 *E. coli* isolates were biotyped based on carbohydrate fermentation patterns with eight sugars viz. adonitol (4.65%), dulcitol (60.46%), mannitol (86.04%), sorbitol (97.67%), raffinose (88.37%), rhamnose (93.02%), salicin (30.23%) and sucrose (81.39%) into 72 different combinations.The most commonly occurring biotypes were IV (42 isolates), VI (40 isolates), XXVIII (39

isolates), V (38 isolates) and III (37 isolates). Sing and Kulshrestha (1994) classified 17 *E. coli* from fresh water fish, fresh water prawn, marine shrimp, dried fish, dried prawn and fish pakoda into 7 biogroup. They found that 11 isolates were belonging to biotype I and other six isolates were belonging to 6 different biotypes. Alagarsamy *et al.* (2010) isolated 155 *E. coli* isolates from aquaculture and other sources. They found that three isolates were belonging into single biotype (7333) and the remaining isolates were of diverse types.

Out of 43 *E. coli* isolates sent for serotyping, 17 isolates could be typed which were distributed into 9 different serogroups whereas 22 isolates did not react with the available O group sera (untypable) and 4 were found to be rough. The serotypes obtained were O11(3), O17(1), O22(1), O35(3), O36(1), O83(2), O84(1), O88(3) and O149(2) (Table 1). Considering the different serotypes detected from different samples, maximum serotypes were isolated from intestine (60.00 %) while not a single serotype was isolated from knife swab.

E. coli serotypes O11 and O17 were reported from raw fish in a study from Punjab (India) (Gupta *et al.,* 2013). In another study O17 and O22 accounted for the predominant serotypes detected in fish STEC isolates (Rao, 2009). In present study, among the isolated serogroups viz. O17 and O35 has been also reported by kapoor *et al.* (1995) from faecal sample which produced verotoxin that was involved in the haemorrhagic enteritis. The same serotypes were also reported by Kapoor and Kulshrestha (1998) from patients of urinary tract infection at different hospitals, IVRI (UP). The untypable isolates were found during the study perhaps belong to some rare serotypes or newer serotypes not yet identified.

CONCLUSION

The most of fresh water fish samples (22.5%) were found to be contaminated or carried *E.coli* infection. *E. coli* was recovered from water samples (52%) followed by intestine (44 %), gills (24%), log swab (24%), skin (16%), muscle (8%), butchers' hand swab (8%) and knife swab (4%). Distributions of *E. coli* into different 72 groups of fermentative biotypes suggest the biodiversity amongst *E. coli* population. Further, occurrence of different serotypes under same biotype and vice-versa was also seen. Different serotypes (09 different O serogroups) like O11, O17, O22, O35, O36, O83, O84, O88 and O149 were recovered during the present investigation. Most of these serotypes were reported in various human diseased conditions as well as animals and have their zoonotic significance.

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LITERATURE CITED

Adesiyun, A. A. 1993. Prevalence of *Listeria* spp., *Campylobacter* spp. *Salmonella* spp. *Yersinia* spp. and toxigenic *Escherichia coli* meat and seafoods in Trinidad. *Food microbiology*, **10** (5), 395-403.

Alagarsamy, S., Thampuran, N., & Joseph, T. C. 2010. Virulence genes, serobiotypes and antibiotic resistance profile of *Escherichia coli* strains isolated from aquaculture and other sources. *Aquaculture research*, **41** (7), 1003-1014.

Ameer, A. A. 2016. Isolation of and characterization of *E. coli* O157/H7 from Common Carp Fish (Cyprinus carpio) in Baghdad governorate. *Mirror of Research in Veterinary Sciences and Animals (MRVSA)*. **5** (2), 33-42.

Ayyappan, S. 2006. National aquaculture sector overview: India. *National Aquaculture Sector Overview Fact Sheets*. FAO, Rome.

Barbosa, M. M. C., Pinto, F. D. R., Ribeiro, L. F., Guriz, C. S. L., Ferraudo, A. S., Maluta, R. P., & Amaral, L. A. 2014. Serology and patterns of antimicrobial susceptibility in *Escherichia coli* isolates from pay-to-fish ponds. *Arquivos do Instituto Biológico*, **81** (1), 43-48.

Barr, J. G., & Hogg, G. M. 1979. Biotypes of Klebsiella pneumoniae (sensu lato) and Enterobacter aerogenes characterised by differential substrate metabolism: application of the technique. *Journal of clinical pathology*, **32** (9), 935-943.

Costa, R. A. 2013. *Escherichia coli* in seafood: a brief overview. *Advances in Bioscience and Biotechnology*, **4**(03), 450.

Edwards, P. R., & Ewing, W. H. 1972. The genus *Salmonella*. *Identification of Enterobacteriaceae*, 146-207.

Eze, E. I., Echezona, B. C., & Uzodinma, E. C. 2011. Isolation and identification of pathogenic bacteria associated with frozen mackerel fish (Scomber scombrus) in a humid tropical environment. *African Journal of Agricultural Research*, **6** (8), 1947-1951.

Gould, L. H., Walsh, K. A., Vieira, A. R., Herman, K., Williams, I. T., Hall, A. J., & Cole, D. 2013. Surveillance for foodborne disease outbreaks—United States, 1998–2008. *Morbidity and Mortality Weekly Report: Surveillance Summaries*, **62** (2), 1-34.

Gupta, B., Ghatak, S., & Gill, J. P. S. 2013. Incidence and virulence properties *of E. coli* isolated from fresh fish and ready-to-eat fish products. *Veterinary World*, **6** (1).

Hansen, D. L., Clark, J. J., Ishii, S., Sadowsky, M. J., & Hicks, R. E. 2008. Sources and sinks of *Escherichia coli* in benthic and pelagic fish. *Journal of Great Lakes Research*, **34** (2), 228-234.

Kapoor, K. N., & Kulshrestha, S. B. 1998. Enterotoxigenic *Escherichia coli* Serotypes from Urinary Tract Infection. *Indian Journal of Comparative Microbiology Immunology and Infectious Diseases*, **19** : 72-73.

Kapoor, K. N., Kulshrestha, S. B., & Kataria, J. M. 1995. Verotoxin Producing *Escherichia coli* from Gastroenteritis Patients. *Indian Journal of Comparative Microbiology Immunology and Infectious Diseases*, **16** : 70-71.

Krishnan, C., Fitzgerald, V. A., Dakin, S. J., & Behme, R. J. 1987. Laboratory investigation of outbreak of hemorrhagic colitis caused by *Escherichia coli* O157: H7. *Journal of clinical microbiology*, **25** (6), 1043-1047.

Li, S., & Mathias, J. A. 1982. Causes of high mortality among cultured larval walleyes. *Transactions of the American Fisheries Society*, **111** (6): 710-721.

Lior, H. 1996. Classification of *Escherichia coli*. In: C.L. Gyles (ed.) *Escherichia coli* in domestic animals and humans. CAB International, Wallingford, United Kingdom. p31-72

Mohamed, M. E., Awadallah, M. A., Amin, M. A., & Abou-Elez, R. M. 2011. Role of Atherina Species in transmitting some bacterial diseases to human. *Journal of American Science,* **7** (1) : 174-185.

Musefiu, T. A., Obuko, E. B., & Bolarinwa, A. O. 2011. Isolation and identification of aerobic bacteria flora of the skin and stomach of wild and cultured Clarias Gariepinus and Oreochromis niloticus from Ibadan, Southwest Nigeria. *Journal of Applied Sciences Research,* **7** (7): 1047-1051.

Nataro, J. P., & Kaper, J. B. 1998. Diarrheagenic *Escherichia coli*. *Clinical microbiology reviews,* **11** (1): 142-201.

Purushottam, Shefali, Agarwal, R. K., Bhilegonkar, K. N., Tomar, A., & Prasad, L. 2011. Isolation and Characterization of *E. coli* from Food and Environmental Samples. *Vegetos-An International Journal of Plant Research*, **24** (1): 142-146.

Quinn, P. J., Markey, B. K., Leonard, F. C., Hartigan, P., Fanning, S., & Fitzpatrick, E. S. 2011. Veterinary Microbiology and Microbial Diseases. 2nd Ed. Wiley-Blackwell.

Rao, T. S. 2009. Studies on detection of shiga toxin-producing *Escherichia coli* in meat and meat products by multiplex polymerase chain reaction and their public health significance Ph.D thesis submitted to the Guru Angad Dev Veterinary and Animal Science University, Ludhiana, India.

Reddy, P. V. G. K. 1999. Genetic resources of Indian major carps. *FAO fisheries technical paper*, (387).

Rocha, R. D. S., Leite, L. O., Sousa, O. V. D., & Vieira, R. H. S. D. F. 2014. Antimicrobial susceptibility of *Escherichia coli* isolated from fresh-marketed Nile tilapia (Oreochromis niloticus). *Journal of pathogens*, 2014.

Sharma, R. K., Agrawal, M., & Marshall, F. 2006. Heavy metal contamination in vegetables grown in wastewater irrigated areas of Varanasi, India. Bulletin of environmental contamination and toxicology, 77 (2), 312-318.

Sifuna, A. W., Njagi, E. N. M., Okemo, P. O., Munyalo, A., Orinda, G. O., & Kariuki, S. 2008. Microbiological quality and safety of Rastrineobola argentea retailed in Kisumu town markets, Kenya.

Singh, B. R., & Kulshrestha, S. B. 1994. Incidence of *Escherichia coli* in fishes and seafoods isolation, serotyping, biotyping and enterotoxigenicity evaluation. *Journal of Food Science and Technology* (India).

Subasinghe R, Soto D, Jia J., 2009. Global aquaculture and its role in sustainable development. *Reviews in Aquaculture*. **1**(1):2-9.

Yagoub, S. O. 2009. Isolation of *Enterobacteriaceae* and *Pseudomonas spp*. from raw fish sold in fish market in Khartoum state. *African Journal of Bacteriology Research,* **1** (7), 085-088.

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An Effect of *Cassia auriculata* Formulated Buttermilk for Diabetics

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ABSTRACT

In the present study the effects of herb on buttermilk formation and its functional properties were investigated. The aqueous extract Cassia *auriculata* herb was used in three proportionate levels for making herbalized buttermilk . The physicochemical analysis was done. Regarding sensory evaluation, control and experimental buttermilk differs with colour and appearance, flavour and overall acceptability except consistency. The samples HBM_2 has reduced in acidity and increase in pH value difference was noticed when compared to control. In samples HBM_2 shows decreased in content of moisture and increase in content of total solids than control. In the samples HBM_2 showed slight difference in fat content than control sample. Regarding protein content, no such difference was observed. As per the results alkaloid, phenol glycoside, flavanoid, tannin, saponin terpenoid, and anthroquinone are observed as positive in treated buttermilk samples (HBM_2) except control. The anti-diabetic effect was trailed and also the study believed as reducing the ability of the blood glucose level by supplementation of herbalized buttermilk for diabetics.

Key words *Buttermilk, cassia auriculata, physiochemical analysis, anti-diabetic effect.*

Recently there has been an increasing interest in the use of natural food additives and incorporation of health promoting substances into the diet. Medicinal and culinary herbs are popularly used in food preparation because they contain phytochemicals which impart variety of health benefits (Exarchau et al., 2002). These beneficial characteristic could increase food safety and shelf life of processed food products (Keerti Yadav, 2014).

Buttermilk is common accompaniment in most of the Indian diet. Originally, buttermilk referred to the liquid left over from churning butter from cultured or fermented cream. Butter is made by churning cream which separates the cream into butter solids and buttermilk. Buttermilk is lower in fat than regular milk, because the fat has been removed to make butter. It is also high in potassium, vitamin B12, calcium, and riboflavin as well as a good source of phosphorus. Buttermilk is one of the probiotic foods. These contain living microorganisms that can survive the passage through the stomach and become active in the intestines. The high amount of lactic acid of the butter milk improves the immune system of the human body, preparing it to fight against diseases. Buttermilk is often included in weight loss diets due to its property of containing all essential nutrients required by our body, whereas it does not contain fats and high amounts of calories. The vitamin B12 in the buttermilk helps in synthesizing the fatty and amino acids, in addition to fighting anemia, stress and promoting growth of nerve cells. The potassium and riboflavin in the buttermilk lowers blood pressure while the calcium improves bone health.

Cassia auriculata (Avaram in Tamil), an evergreen shrub famous for its beautiful yellow flowers, grows wild in India. Its bark, which contains 18 percent tannin, is often used in the tanning of leather. In Ayurvedic medicine, *Cassia auriculata* root is used to treat fevers, diabetes, diseases of the urinary system, and constipation, while the leaves are used as a laxative and the dried flowers are used for polyurea. Some *in-vivo* researches revealed that an extract of Cassia auriculata flowers suppressed elevated blood glucose and lipids in diabetic rats as well as standard drug ailments. The flower extract is proven to have anti-diabetic activity. Consumption of *Cassia auriculata* flowers in the form of tea lowers blood sugar level.

The consumption of dairy products in recent decade has increased rapidly due to the fact that this dairy product meets many consumer dietary needs. Attempts to make the fermented milk more palatable and nutritious have recently extended in the inclusion of rare fruits, probiotics, prebiotic and additives (Keerti Yadav, 2014). In this regard the inclusion of *Cassia auriculata* herb is expected to enhance the nutritional values of buttermilk and as such enhanced existing perceived values of herbal buttermilk.

MATERIALS AND METHODS

The present study was carried out in the Dairy Science Laboratory of School of Agriculture and Animal Sciences, Gandhigram Rural Institute - Deemed University, Gandhigram, Dindigul District, Tamilnadu, India.

Materials

Raw milk was procured from Dairy farm of our university. Microbial dahi starter culture (lactic acid bacteria) was collected from Department of Livestock Products Technology, Veterinary College and Research Institute, Namakkal. *Cassia auriculata* (Avaram) flowers, seeds and leaves were collected from "C farm" of our university. Blood glucose monitoring system (ONE TOUCH) was purchased from Johnson Pvt Ltd, Mumbai - 400 080.

Methods

Preparation of herbal aqueous extract

The fresh *Cassia auriculata* flowers, seeds and leaves of each part were selected equal quantity. Then the parts of plants are cleaned and made into fine powder using mechanical mixer. Herbal water extract was prepared by soaking *Cassia auriculata* powder in distilled water (1:10) overnight followed by centrifugation (2000 rpm; 15 min at 40ºC). The supernatant was harvested and refrigerated and used in the preparation of herbal buttermilk within 3 days.

Flow chart for the preparation of herbal buttermilk

Raw milk
↓
Filtration
↓
Pasteurization at 85ºC for 30 min
↓
Allowed to cool (40ºC)
↓
Addition of *Cassia auriculata* herb aqueous extract @ 1%, 3% and 5% / mL
↓
Inoculation with 2% lactic acid bacteria starter culture (LAB)
↓
Incubated at 37ºC±1ºC for 8 hours
↓
Transferred to cold storage after reaching desired acidity and pH
↓
Breaking the coagulum
↓
Addition of water at desired level (1:1 ratio)
↓
Stir vigorously
↓
Packed and sealed into polyethylene pouches & Storage below 5ºC for 7 days

Procedure adopted for manufacturing of control and herbal buttermilk

The herbalised buttermilk was prepared by using raw milk (1 liter), lactic acid bacteria (2 %) and *Cassia auriculata* herb aqueous extract. The fresh raw milk was heated till temperature reached to 85ºC for 30 minutes and cooled to 45ºC. Then the pasteurized milk was stirred well with herb aqueous extract at desired level. This herbal curd mix was inoculated with 2 percent lactic acid bacteria culture containing *Lactobacillus bulgaricus*. Then it kept for incubation at 37ºC for 8 hours. After reaching the lactic acid strength (0.7±2%) and pH (4.6), the coagulum was broken vigorously by mechanical stirrer with potable water at the ratio of 1:1. Then this herbal buttermilk was packed and sealed into 100ml polyethylene pouches. It was stored under refrigerated condition at below 5ºC for 7 days.

In the present study, 1, 3 and 5 percentages of three different proportionate *cassia auriculata* herb aqueous extract blended buttermilk which were compared with plain butter milk (control-C) and the samples were coded as, HBM_1, HBM_2 and HBM_3 respectively.

Sensory evaluation

The nine point's hedonic rating scale was used to measure the sensory evaluation of developed buttermilk. The control and *Cassia auriculata* added buttermilk samples were served to the semi trained panelist, and the members were asked to rate the acceptability of the samples ranging from like extremely to dislike extremely.

Physicochemical analysis

All the samples were analyzed for the Protein (Pyne's method), Fat (Gerber method) and Acidity (Titration method) using the method as described by IS: 1479 (Part II) 1961. The pH was measured using digital pH meter. Blood glucose level was analyzed by using one touch blood glucose monitoring method. Phytonutrients were determined by AOAC (2000)

RESULTS AND DISCUSSION

The results presented in the table no.1 showed that Mean± SE value of sensory evaluation of herbal buttermilk. The product was analyzed for sensory attributes like colour and appearance, flavour, consistency and overall acceptability. Regarding sensory evaluation, control and experimental buttermilk differs with colour and appearance, flavour and overall acceptability than consistency. The respective mean value of sensory scores of control, HBM_1, HBM_2 and HBM_3 are follows; 8.2±0.08, 7.25±0.04, 7.26±0.06 and 6.95±0.11 respectively. When compared to control sample the maximum score was obtained for HBM_2 and the minimum scores were obtained for HBM_1. A high scored sample (HBM_2) was taken for further study which was compared with control. The results are shown in figure1.

The value of acidity and pH was determined at storage of refrigerated period of 7 days. Average percentage of acidity in control sample was determined as 0.42±0.5 level and for herbal buttermilk ranged from 0.20±0.2 to 0.22±0.5 throughout storage period which cane been the treatment of herbal extract in buttermilk. The average value of pH in control sample was determined as 5.01±0.2 level and for herbal buttermilk ranged from 5.20±0.2 to 5.22±0.3

Table 1. Mean± SE value of Sensory evaluation of herbal buttermilk

Palatability	Control	HBM_1	HBM_2	HBM_3
Colour and appearance	8	7.3	7.1	7
Flavour	8.2	7.3	7.4	6.9
Consistency	8.2	7.2	7.3	7.4
Overall acceptability	8.4	7.1	7.22	6.9
Mean± SE	8.2±0.08	7.25±0.04	7.26±0.06	6.95±0.11

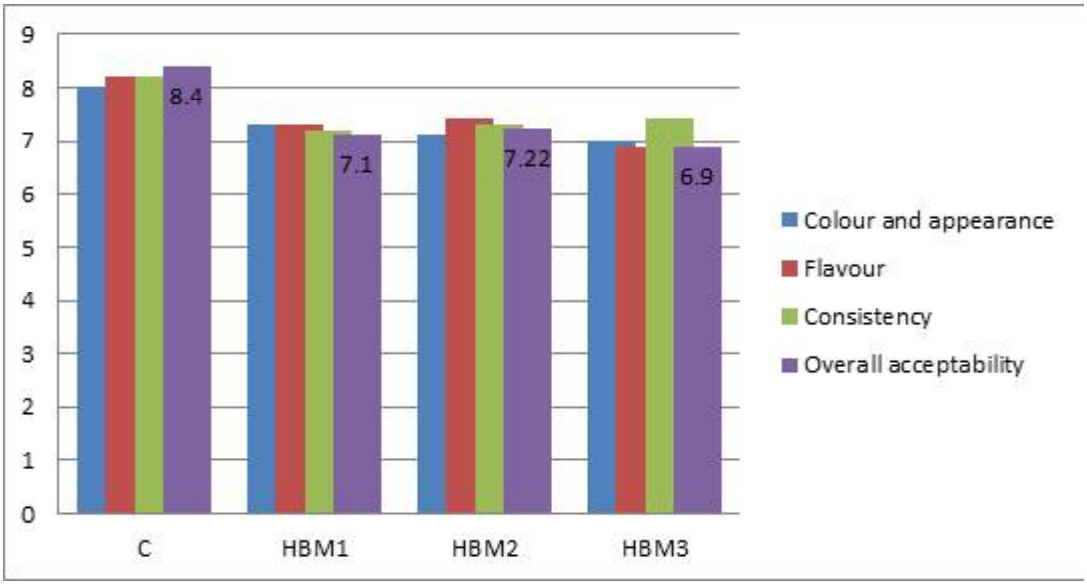

Fig. 1. Sensory evaluation of Herbal buttermilk

throughout storage period. In control sample there was no major difference was observed in acidity and pH at different periods of refrigerated storage. But in treatment buttermilk sample (HMB_2) has reduced in acidity and increase in pH value these difference was noticed when compared to control which may due to the addition of *Cassia auriculata* powder. When the acidity increases the pH will be decreased as they are negatively correlated parameter. At the refrigerated storage temperature of buttermilk, there will be metabolic action of lactic acid bacteria, resulting in the acidity and a decrease in pH. Walstra et al. 2006 studies recorded that the pH was reduced to 4.43 - 4.5 in the fermented products. In respect to the value of moisture and total solid percentage of samples control and HBM_2 was 89.2±0.2 and 10.8±0.3 throughout storage period. There was no major difference was noticed.

The results presented in the table no.2 showed that Mean± SE value of proximate composition of herbal buttermilk samples. The average value of fat content of control sample was 3.11 ±0.05 and HBM_2 was 3.02±0.18. The samples HBM_2 showed slight differences in fat content than control sample. Based on the protein content of developed product the average value of control sample was 3.43±0.11 and HBM_2 was 3.58±0.20. In the case of protein content there was no major difference was observed. The values was differs slightly in both samples at refrigerated storage periods. Libud Zisz and Stepaniak 2003 study determined that protein content of buttermilk was 3.21/100g.

The phytonutrients quality was determined. As per the results alkaloid, phenol glycoside, flavanoid, tannin, saponin terpenoid, and anthroquinone are observed as

Table 2. Mean± SE value of Proximate composition of herbal buttermilk samples

Sample	Fat (%)			Protein (%)		
	0day	3rdday	7thday	0day	3rdday	7thday
Control	3.13±0.01	3.11±0.05	3.09±0.02	3.4±0.11	3.5±0.01	3.4±0.05
HBM2	3.12±0.25	2.96±0.18	2.98±0.03	3.61±0.11	3.63±0.20	3.5±0.05

Table 3. Value of glucose level of respondents supplemented with herbal buttermilk

Days	Respondent No.1		Respondent No.2		Respondent No.3	
	F (mg/dl)	P (mg/dl)	F (mg/dl)	P (mg/dl)	F (mg/dl)	P (mg/dl)
1stday	167	230	145	180	211	286
7thday	159	202	112	141	179	236
14thday	146	187	110	143	181	278
21stday	151	210	117	138	186	269
28thday	140	208	102	131	180	259

*F:Fasting; P:Postprandial

positive manner in treated buttermilk samples (HBM_2) except control which may the effect of *Cassia auriculata* powder in buttermilk. The result are in agreements with finding of Kalaivani et al 2008, who observed the phytonutrients presence while screening the ethanol extract of flowers and leaves of *Cassia auriculata* plant.

The results presented in the table no.3 showed that value of glucose level of respondents supplemented with herbal buttermilk. The anti-diabetic effect was trailed with supplementation of 120ml of herbalised buttermilk (HBM_2) to three 55 plus aged diabetic women's for 30 days and blood glucose level (fasting and postprandial) was checked periodically (once in 7 days) by one touch blood gluco meter. Finally treated weeks of blood glucose level were compared with initial day. Over a period of supplementation, in this trail was proved to reduce the blood glucose level by supplementation of herbalized buttermilk. These results are in agreement with the findings of *invitro* diabetic studies of Kalaivani et al, 2008.

LITERATURE CITED

Exarchau,V. Nenadis, N.Tsimidou, M.Gerothanassis, I. P, Troganis, A., & Boskou, D. 2002. Antioxidant activities and phenolic composition of extracts from Greek sage and summer sovory. *Journal of Agriculture &Food Chemistry*, 50(19),5294-5299.

Keerti Yadav 2014. Thesis titled "Production and quality evaluation of herbal yogurt" Sam Higginbottom Institute of Agriculture, Allahabad, India.

Kalaivani *et al.*2008 anti-hyperglycemic and antioxidant properties of *cassia auriculata* leaves and flowers on alloxaninduced diabetic rats Department of Biochemistry, P.G.P.College of Arts and Science, Namakkal

Libudzisz Zand Stepaniak L, 2003 Buttermilk. In : Encyclopedia of Dairy science, Vol 2,

Walstra, Wouters and Geurts, 2006 Dairy science and technology , pp: 551-558, 2nd edition. Boca Raton London New York : Taylor & Francis Group, LCC.

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Screening of Greengram (*Vigna radiata* (L) Wilczek) Genotypes against *Bemisia tabaci* (Gennadius) and *Mungbean yellow mosaic virus* in Tamil Nadu

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ABSTRACT

***Mungbean Yellow Mosaic Virus* (Begomovirus; Geminiviridae) is a major constraint in mungbean production in Tamil Nadu especially during summer season. It is mainly transmitted by the vector whitefly *Bemisia tabaci* (Gennadius), (Hemiptera: Aleyrodidae. About160 greengram genotypes and germplasm were screened during summer-2017, *kharif*-2017, *rabi*- 2017 and summer-2018 against *B. tabaci* and MYMV. Found that no genotype was resistant to *B. tabaci* , 11 genotypes were moderately resistant to whitefly (SME 2017-72, SME 2017-73, SME 2017-74; Annus -2, LM 43; SME 2017-85, SME 2017-83, KME 16-44, MLT-GG-SI-17-001, MLT 17-002 , MLT 17-004) and 3 genotypes (Pusa Reagate, IC 39344, and ML 1012) were moderately resistant to both *B. tabaci* and MYMV under field condition. These resistance genotypes may be used for breeding programme.**

Keywords *Bemisia tabaci, Field screening, Greengram genotypes, MYMV.*

Greengram (*Vigna radiata* (L.) Wilczek) or mungbean is an important pulse crop grown in India. The crop occupies an area of 3.5 million ha with an annual production of 1.8 million tonnes and productivity of 406 kg ha^{-1} (Singh *et al*., 2015). One of the major reasons for low productivity is attack of *Mungbean yellow mosaic virus* (MYMV) which is belongs to genus Begomovirus and family Geminiviridae (Bos 1999). The presence of mixed yellow green spots, leaf mottling, yellowing on leaves and pods are the symptom of damage and may cause up to 100 per cent yield loss (Mallick 1980, Bashir et al. 2006; Parihar *et al*., 2016). At least two strains of MYMD were identified in India (Tsai, 2013) one is *Mungbean yellow mosaic india virus* (MYMIV) which is more predominant in northern, central and eastern regions (Usharani *et al*. 2004) and another one is and MYMV in southern region particularly in Tamil Nadu (Karthikeyan *et al*. 2004; Girish and Usha 2005; Haq *et al*. 2011). Both the strains are transmitted by the vector *B. tabaci* in a persistent and circulative manner (Markham *et al*. 1994).

The *B. tabaci* is polyphagous, global pest and about 40 cryptic species so far recorded (Hu *et al.,* 2017). Among these nine genetic groups were reported in India (Ellango *et al*., 2015; Prasanna *et al*., 2015; Ramkumar *et al*.,2017) from different regions, where the cryptic species Asia II 1 is predominant in North India and Asia II 8 is predominant from south India (Nair *et al*., 2017). Besides the *B.tabaci* cryptic species Asia II 8 is being closely associated with MYMV hotspot regions of Tamil Nadu (Ranjithkumar, 2018).

However, at present farmers are mainly containing the disease through vector control by insecticide application *viz*., imidacloprid 70% WS (Jyothi *et al*., 2013), thiamethoxam, dinotefuron, and acetamiprid (Esashika *et al*., 2016) and thiamethoxam (Swathi and Gaur 2017).

Screening of germplasm and accessions against major pests is an important and continuous task in the breeding programme. Several resistance sources had been reported before (Chhabra and Kooner, 1993; Kooner, 1998; Kooner and Cheema, 2007) but their performance were influenced by the geographical and environmental factors (Parihar et al., 2016). Hence identification of regional specific resistance sources is very crucial to cope with changing climatic conditions. With this background the present study was undertaken to screen the mungbean genotypes against *B.tabaci* and MYMV and to identify the resistant sources suitable to Tamil Nadu conditions.

MATERIAL AND METHODS

Field screening of mungbean (CO 8) against *B. tabaci* and MYMV were recorded during summer -2017, *Kharif* -2017, *Rabi*-2017 and summer -2018 at the Department of Pulses, TNAU, Coimbatore. The mungbean genotypes and germplasm are received from different AICRP-MULLaRP centers. Each entry was sown in double row of three meter length with the spacing of 30 × 10 cm in two replications. For every five test entries both national check (SML 1082) and local check (CO 8) were kept for comparison. All the recommended agronomic practices were followed. No insecticidal spray was given in order to allow the whitefly population to spread the disease. The observation was taken on a three randomly selected plants at weekly interval starting from ten days after sowing. The number of whitefly adult(s) per plant was counted manually. The MYMV incidences were observed at weekly interval starting from ten days after sowing. Visual observation was made based on the symptom expression on the number of MYMV

infected plants out of total number of plants and the per cent disease incidence was worked out. The pest resistance index was worked out using the following formula and graded accordingly (Salam *et al.* 2009).

$$PRP = \frac{\text{No.of whitefly adults in the check entry - No. of whitefly adults in the test entry x 100}}{\text{No. of whitefly in the check entry}}$$

Pest Resistant Percent (PRP)	Grade	Resistance level
100	1	Highly Resistant
75 to100	2	Resistant
50 to75	3	Moderately Resistant
25 to 50	4	Moderately Resistant
10 to 25	5	Susceptible
10 to-10	6	Susceptible
-10 to -25	7	Susceptible
-25 to -50	8	Highly Susceptible
Less than -50	9	Highly Susceptible

The per cent disease incidence was observed by counting number of infected plants and total number of plants per row. PDI was calculated by adopting the following formula (Salam *et al.* 2009).

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants x 100}}{\text{Total number of plants}}$$

Disease Score	Percent Infection	Category	Reaction group
0	No plants showing any symptoms	Immune	I
1	Less than 1% plants exhibiting symptoms	Resistant	R
2	1-10 % plants exhibiting symptoms	Moderately Resistant	MR
3	11-20 % plants exhibiting symptoms	Moderately Susceptible	MS
4	21-50% infection	Susceptible	S
5	50 % and more plants exhibiting symptoms	Highly Susceptible	HS

RESULTS AND DISCUSSION

Summer-2017

A total of 41 genotypes and 38 germplasm lines were screened against whitefly and MYMV disease in during summer 2017. Among the genotypes none of them was found to be resistant to whitefly and the genotypes *viz*., SME 16-34, MLT 17-004, MLT 17-009 and KME 16-31 were found to be moderately resistance to whitefly. The genotypes *viz*., SME 2017-71 , SME 2017-77, SME 2017-79, MLT 17-005, SME 16-38, RME 16-5, RME 16-6, RME 16-7, RME 16-8, KME 16-22, KME 16-23, KME 16-24, KME 16-25, KME 16-26, KME 16-27 , KME 16-28, KME 16-29, KME 16-32 and KME 16-33 were found to be highly susceptible to whitefly (Table 1).

Among the 38 germplasm screened, none of them was found to be resistant to whitefly and MYMV. The germplasm lines *viz*., Pusa Reagate, IC 39344, and ML 1012 showed moderately resistance to whitefly and MYMV. The germplasm like Annus -2 and LM 43 were moderately resistance to whitefly. The germplasm *viz*., LM 222 (D), RNG 226/1, LM 207, EC 96100, VG 672, V 1388, PLS 302 and ML 1278 showed susceptible to whitefly and the entries like ML 1012, PLS 269A, ML 3, T 3485/1, IC 1163, PLS 302, LM 63, LM 115, and Bina mung 2 showed highly susceptible to whitefly (Table 2).

Kharif - 2017

Among the 34 genotypes screened, none of them was resistant to whitefly. The genotypes such as SME 2017-85, SME 2017-83, KME 16-44, MLT-GG-SI-17-001, MLT 17-002 and MLT 17-004 were found to be moderately resistance to whitefly. SME 2017-80, SME 2017-81, SME 2017-82, SME 2017-84, KME 16-43, KME 16-46, KME 16-25, SME 2017-105, SME 2017-106 and SME 2017-108 genotypes are susceptible to whitefly. KME 16-42, KME 16-45, RME 16-2, RME 16-5, RME 16-6, RME 16-7, RME 16-8, KME 16-24, KME 16-25, KME 16-26, KME 16-27, KME 16-28 and KME 16-29 genotypes were highly susceptible to whitefly (Table 3).

Rabi -2017

During *Rabi* 2017, 29 genotypes were screened against whitefly and MYMV incidences. Among these genotypes none of them was resistant to whitefly. The genotypes *viz*., RME-17-1, RME-17-4, RME-17-6, RME 17-7, RME 17-14 and MLT-GG-R-17-07 showed moderately resistance to whitefly. The genotypes such as MLT-GG-R-17-05, MLT-GG-R-17-12, MLT-GG-R-17-13, RME 17-14 and RME 17-16 were highly susceptible to whitefly (Table 4).

Summer -2018

Among 18 genotypes screened, none of them was resistant to whitefly. MLT-GG-SI-SI-07 and MLT-GG-SI-SI-10 genotypes showed moderately resistance to whitefly.

Table.1. Performance of different greengram genotypes against *B. tabaci* and MYMV incidence during summer- 2017

Genotypes	PRP	Grade	PDI	Grade
SME 2017-71	-73.9	9	15.3	2
SME 2017-72	-15.3	7	35.4	3
SME 2017-73	-18.7	7	16.8	2
SME 2017-74	-24.4	7	47.4	4
SME 2017-75	-16.4	7	34.8	4
SME 2017-76	-42.8	8	12.6	2
SME 2017-77	-70.4	9	25.8	3
SME 2017-78	-31.3	8	40.5	4
SME 2017-79	-95.7	9	32.7	4
SME 2017-80	-40.5	8	47.4	4
MLT 17-003	-21.0	7	27.9	3
MLT 17-004	4.2	6	50.1	5
MLT 17-005	-53.2	9	40.5	4
MLT 17-006	-31.3	8	53.2	5
MLT 17-007	-34.8	8	12.7	2
MLT 17-008	-31.3	8	22.6	3
MLT 17-009	-8.4	6	15.3	2
MLT 17-001	-47.4	8	34.8	4
SME 16-8	-21.0	7	15.5	2
SME 16-29	-27.9	8	9.6	1
SME 16-34	5.3	5	30.1	4
SME 16-37	-40.5	8	27.4	3
SME 16-38	-72.7	9	21.0	3
RME 16-4	-21.0	7	32.7	4
RME 16-5	-55.5	9	40.5	4
RME 16-6	-65.8	9	14.2	2
RME 16-7	-60.1	9	32.7	4
RME 16-8	-60.1	9	47.4	4
RME 16-9	-47.4	8	28.5	3
KME 16-22	-72.7	9	34.8	4
KME 16-23	-117.6	9	53.2	5
KME 16-24	-72.7	9	15.8	2
KME 16-25	-27.9	8	27.9	3
KME 16-26	-65.8	9	34.2	4
KME 16-27	-85.4	9	35.8	4
KME 16-28	-104.9	9	47.4	4
KME 16-29	-53.2	9	22.6	3
KME 16-30	-21.0	7	53.2	5
KME 16-31	-8.4	6	47.4	4
KME 16-32	-47.4	8	47.4	4
SML 1082	-8.4	6	34.8	4
CO 8	-12.8	7	36.7	4

Table 2. Performance of different greengram genotypes against *B. tabaci* and MYMV incidence during summer- 2017

Genotypes	PRP	Grade	PDI	Grade
Annus -2	9.9	5	27.9	3
ML18897	4.2	6	50.1	5
Bina mung-2	-21.0	7	47.4	4
ML 1012	-53.2	9	34.8	4
PLS 269A	-60.1	9	15.5	2
Pusa Reagate	16.8	5	19.6	2
A 154	-2.6	6	27.4	3
LM 222(D)	-40.5	8	47.4	4
RNG 226/1	-15.3	7	15.3	2
ML 3	-85.4	9	35.4	3
IC 39344	16.8	5	16.8	2
RNG 226/1	-47.4	8	15.3	2
PAU 911	-2.6	6	34.8	4
T 3485/1	-65.8	9	53.2	5
LM 207	-40.5	8	15.8	2
IC 1163	-72.7	9	27.9	3
EC 96100	-47.4	8	21.0	3
SML 1077	-27.9	7	32.7	4
PLS 302	-60.1	9	40.5	4
VG 672	-40.5	8	14.2	2
LM 63	-53.2	9	34.2	4
LM 115	-72.7	9	35.8	4
MAU 3486	-15.3	7	22.6	3
V 1388	-34.8	8	53.2	5
PLS 302	-40.5	8	47.4	4
ML 1278	-47.4	8	12.6	2
LM 43	9.9	5	25.8	3
LM 29	4.2	6	40.5	4
M118897	-21.0	7	47.4	4
ML 1012	16.8	5	12.7	2
SML 1082	-8.4	6	27.4	3
CO 8	-12.8	7	36.7	4

MLT-GG-SI-18-01, MLT-GG-SI-SI-06, MLT-GG-SI-SI-13. The genotypes such as MLT-GG-SI-18-02, MLT-GG-SI-18-04, MLT-GG-SI-18-05 and MLT-GG-SI-SI-11 were found to be highly susceptible to whitefly (Table 5).

Among 160 greengram genotypes and germplasm screened against *B.tabaci* (Tables 1 to 5) none of them found to be resistant to *B. tabaci* and few genotypes were found to be moderately resistant to whitefly (SME 2017-72, SME 2017-73, SME 2017-74; Annus -2, Row 7 and LM 43;

Table 3. Performance of different greengram genotypes against *B. tabaci* and MYMV incidence during *kharif* 2017

Genotypes	PRP	Grade	PDI	Grade
SME 2017-80	-40.5	8	57.2	5
SME 2017-81	-34.8	8	18.5	3
SME 2017-82	-32.0	8	12.7	2
SME 2017-83	-8.4	6	11.6	2
SME 2017-84	-40.5	8	32.7	4
KME 16-42	-65.8	9	27.9	3
KME 16-43	-47.4	8	15.8	2
KME 16-44	-2.6	6	15.4	2
KME 16-45	-53.2	9	20.9	3
KME 16-46	-47.4	8	33.2	4
SME 2017-109	-21.0	7	21.0	3
MLT-GG-SI-17-001	-8.4	6	34.8	4
MLT 17-002	-8.4	6	15.5	2
MLT 17-003	-21.0	7	8.4	1
MLT 17-004	4.2	6	30.1	4
RME 16-2	-65.8	9	27.4	3
RME 16-3	-21.0	7	21.0	3
RME 16-4	-21.0	7	32.7	4
RME 16-5	-55.5	9	40.5	4
RME 16-6	-65.8	9	14.2	2
RME 16-7	-60.1	9	32.7	4
RME 16-8	-60.1	9	47.4	4
KME 16-24	-72.7	9	28.5	3
KME 16-25	-27.9	8	34.8	4
KME 16-26	-65.8	9	53.2	5
KME 16-27	-85.4	9	34.8	4
KME 16-28	-104.9	9	12.6	2
KME 16-29	-53.2	9	25.8	3
KME 16-30	-21.0	7	40.5	4
SME 2017-85	1.8	5	32.7	4
SME 2017-105	-34.8	8	47.4	4
SME 2017-106	-37.1	8	27.9	3
SME 2017-107	-65.8	9	50.1	5
SME 2017-108	-40.5	8	40.5	4
SML 1082	1.2	6	12.1	2
CO 8	-8.4	6	28.6	3

Table 4. Performance of different greengram genotypes against *B. tabaci* and MYMV incidence during *rabi* -2017

Genotypes	PRP	Grade	PDI	Grade
MLT-GG-R-17-01	-16.5	7	14.7	2
MLT-GG-R-17-02	-23.7	7	33.7	4
MLT-GG-R-17-03	-40.6	8	31.2	4
MLT-GG-R-17-04	-35.8	8	15.0	2
MLT-GG-R-17-05	-55.0	9	25.5	3
MLT-GG-R-17-06	-18.9	7	28.9	3
MLT-GG-R-17-07	12.3	5	42.3	4
MLT-GG-R-17-08	-33.4	8	53.8	5
MLT-GG-R-17-09	-47.8	8	17.8	2
MLT-GG-R-17-10	-33.4	8	22.3	3
MLT-GG-R-17-11	-52.6	9	34.8	4
MLT-GG-R-17-12	-38.2	8	44.8	4
MLT-GG-R-17-13	-57.4	9	51.2	5
RME-17-1	12.0	5	18.5	3
RME-17-2	-26.1	8	12.7	2
RME-17-3	-18.9	7	11.6	2
RME-17-4	-4.5	6	32.7	4
RME-17-5	-38.2	8	27.9	3
RME-17-6	-4.5	6	15.8	2
RME 17-7	2.6	6	15.4	2
RME 17-8	-45.4	8	20.9	3
RME 17-9	-18.9	7	33.2	4
RME 17-10	-35.8	8	21.0	3
RME 17-11	-28.5	8	38.4	4
RME 17-12	-31.0	8	27.4	3
RME 17-13	7.5	6	30.5	4
RME 17-14	-62.2	9	20.1	2
RME 17-15	-16.5	7	37.4	4
RME 17-16	-59.8	9	38.5	4
SML 1082	12.3	5	22.3	3
CO 8	6.9	6	29.3	3

SME 2017-85, SME 2017-83, KME 16-44, MLT-GG-SI-17-001, MLT 17-002 and MLT 17-004) and some genotypes (Pusa Reagate, IC 39344, and ML 1012) were found to be moderately resistant to both *B. tabaci* and MYMV under field condition and these entries might be used for breeding program. The results of present screening were in accordance with several other findings. Mohan *et al*. (2014) evaluated 120 germplasm lines and 15 germplasm lines are resistant to MYMV under field condition. Iqbal *et al*. (2011) screened 100 lines of mungbean germplasm and out of which only four lines shows resistance under field condition. Salam *et al.* (2009) found 3 lines out of 93 genotypes as resistant. Habib *et al*. (2007) evaluated 108 germplasm lines but no resistant line was found. Shad *et al*., (2006) found that there was no resistant line against MYMV and identification of seven susceptible and 247 as highly susceptible lines exhibited meager resistance in mungbean. Datta *et al*. (2012) also reported the resistance nature of the genotype. Similarly Asthana (1998) and Paul *et al*. (2013) reported ML 1012 as variety resistant to yellow mosaic and recommended for use in disease resistance breeding programs. The genotypes grouped under resistant category would be utilized as donors to develop MYMV resistant lines.

Table 5. Performance of different greengram genotypes against *B. tabaci* and MYMV incidence during summer- 2018

Genotypes	PRP	Grade	PDI	Grade
MLT-GG-SI-18-01	-27.9	7	34.8	4
MLT-GG-SI-18-02	-60.1	9	15.5	2
MLT-GG-SI-18-03	-40.5	8	6.6	1
MLT-GG-SI-18-04	-53.2	9	30.1	4
MLT-GG-SI-18-05	-72.7	9	27.4	3
MLT-GG-SI-06	-22.6	7	21.0	3
MLT-GG-SI-07	15.3	5	32.7	4
MLT-GG-SI-08	-34.8	8	40.5	4
MLT-GG-SI-09	-40.5	8	14.2	2
MLT-GG-SI-10	-2.6	6	32.7	4
MLT-GG-SI-11	-60.1	9	55.7	5
MLT-GG-SI-12	-47.5	8	18.5	3
MLT-GG-SI-13	-21.0	7	12.7	2
SML 1082	-25.7	7	15.8	2
CO 8	-17.0	7	14.7	2

MLT: Multi Location Trials, GG: Greengram, S: Summer, SI: Summer Irrigated, R: Rice Fellow RME: Rabi Mungbean for Entomology screening; KME: Kharif Mungbean for Entomology screening.

CONCLUSION

The result of this study show that the some of the genotypes are moderately resistance to both whitefly and MYMV in field condition. These MYMV resistant mungbean genotypes can probably be developed by adopting future breeding programmes.

LITERATURE CITED

Asthana, A. N. 1998. Pulse crops research in India. *Indian Journal of Agriculture Science*, **68**(8):448–52.

Bashir, M., Z. Ahmad and S. Mansoor. 2006. Occurrence and distribution of viral diseases of mungbean and mashbean in Punjab. *Pakistan journal of botany*, **38**(4):1341-1351.

Bos, L. 1999. *Plant Viruses: Unique and Intriguing Pathogens: A Text Book of Plant Virology*, Backhuys Publishers, Leiden.

Datta, S., S. Gangwar, S. Kumar, S. Gupta, R. Rai1, M. Kaashyap, P. Singh, S. K. Chaturvedi, B. B. Singh and N. Nadarajan. 2012. Genetic diversity in selected Indian Mungbean [*Vigna radiata* (L.) Wilczek] Cultivars Using RAPD Markers. *American Journal of Plant Science*, **3**:1085–91.

Chhabra, K., and B. Kooner. 1993. Screening of mungbean germplasm against insect pests and yellow mosaic virus. *Indian Journal of Pulses Research,* **6**(1):69-75.

Ellango, R., S. T. Singh, V. S. Rana, N. Gayatri Priya, H. Raina, R. Chaubey, N. Naveen, R. Mahmood, V. Ramamurthy and R. Asokan. 2015. Distribution of *Bemisia tabaci* genetic groups in India. *Environmental entomology,* **44**(4):1258-1264.

Esashika, D. A., M. Michereff-Filho, C. S. Bastos, A. K. Inoue-Nagata, A. M. Dias and M. G. Ribeiro. 2016. Susceptibility of *Bemisia tabaci* biotype B to insecticides. *Horticultura Brasileira,* **34**(2):189-195.

Girish, K., and R. Usha. 2005. Molecular characterization of two soybean-infecting begomoviruses from India and evidence for recombination among legume-infecting begomoviruses from South-East Asia. *Virus Research,* **108**(1-2), 167-176.

Habib, S., N. Shad, A. Javaid and U. Iqbal. 2007. Screening of mungbean germplasm for resistance/tolerance against yellow mosaic disease. *Mycopathology*, **5**(2):89–94.

Haq, Q., P. Jyothsna, A. Ali and V. Malathi. 2011. Coat protein deletion mutation of Mungbean yellow mosaic India virus (MYMIV). *Journal of Plant Biochemistry and Biotechnology,* **20**(2): 182.

Hu, J., X. Zhang, Z. Jiang, F. Zhang, Y. Liu, Z. Li and Z. Zhang. 2017. New putative cryptic species detection and genetic network analysis of *Bemisia tabaci* (Hempitera: Aleyrodidae) in China based on mitochondrial COI sequences. *Mitochondrial DNA Part A.,* 1-11.

Iqbal, U., S. M. Iqbal, R. Afzal, A. Jamal, M. A. Farooq and A. Zahid. 2011. Screening of Mungbean germplasm against Mungbean Yellow Mosaic Virus (MYMV) under field conditions. *Pakistan Journal of Phytopathology*, **23**(1):48–51.

Jyothi, V., N. Nagaraju, A. Padmaja and K. Rangaswamy. 2013. Transmission, detection and management of yellow mosaic virus in polebean (*Phaseolus vulgaris* L.). *Journal of Mycology and Plant Pathology,* **43:**229-236.

Karthikeyan, A., R. Vanitharani, V. Balaji, S. Anuradha, P. Thillaichidambaram, P. Shivaprasad, C. Parameswari, V. Balamani, M. Saminathan and K. Veluthambi. 2004. Analysis of an isolate of Mungbean yellow mosaic virus (MYMV) with a highly variable DNA B component. *Archives of Virology,* **149**(8): 1643-1652.

Kooner, B. 1998. *Identification of sources of resistance to whitefly, jassids and MYMV in kharif mungbean.* Paper presented at the Proceedings of national symposium on management of biotic and abiotic stresses in pulse crops. Indian Society of Pulses Research and Development, Kanpur.

Kooner, B., and H. Cheema. 2007. Screening of black gram germplasm for resistance to whitefly, *Bemisia tabaci* (Gennadius) and MYMV. *Journal of Insect Science-Ludhiana*, **20**(1):124.

Mallick, C. P., and M. B. Singh. 1980. *Plant enzymology and Histoenzymology*. Kalyani publishers, New Delhi, 286.

Markham, P. G., I. D. Bedford, S. Liu and M. S. Pinner. 1994. The transmission of geminiviruses by *Bemisia tabaci*. *Pest Management Science,* **42**(2), 123-128.

Mohan, S., A. Sheeba, E. Murugan and S. M. Ibrahim. 2014. Screening of Mungbean Germplasm for Resistance to Mungbean Yellow Mosaic Virus under Natural Condition. *Indian Journal of Science and Technology*, **7**(7):891–896.

Nair, R., M. Gotz, S.Winter, R. Giri, V. Boddepalli, A. Sirari, T. Bains, G. Taggar, H. Dikshit and M. Aski. 2017. Identification of mungbean lines with tolerance or resistance to yellow mosaic in fields in India where different begomovirus species and different *Bemisia tabaci* cryptic species predominate. *European Journal of Plant Pathology,* **149**(2): 349-365.

Parihar, C. M., M. R. Yadav, S. L. Jat, A. K. Singh, B. Kumar, S. Pradhan, D. Chakraborty, M. L. Jat, R. K. Jat, Y. S. Saharawat, and O. P. Yadav. 2016. Long term effect of conservation agriculture in maize rotations on total organic carbon, physical and biological properties of a sandy loam soil in north-western Indo-Gangetic Plains. *Soil and Tillage Research,* **161**: 116–28.

Paul. P. C., M. K. Biswas, D. Mandal and P. Pal. 2013. Studies on host resistance of Mungbean against Mungbean Yellow Mosaic Virus in the agro-ecological condition of lateritic zone of West bengal. *The Bioscan Journal*, **8**(2):583–87.

Prasanna, H., S. Kanakala, K. Archana, P. Jyothsna, R. Varma and V. Malathi. 2015. Cryptic species composition and genetic diversity within *Bemisia tabaci* complex in soybean in India revealed by mtCOI DNA sequence. *Journal of Integrative Agriculture,* **14**(9):1786-1795.

Ramkumar, N., J. C. Chang, M. B. Narayanan and S. Ramasamy. 2017. Phylogeographical structure in mitochondrial DNA of whitefly, *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) in southern India and Southeast Asia. *Mitochondrial DNA Part A,* **28**(5): 621-631.

Ranjith Kumar.R. 2018. Deciphering the preference of *Bemisia tabaci (*Hemiptera: Aleyrodidae*) vis-a-vis Mungbean yellow mosaic virus* (Begomovirus; Geminiviridae) infection status in Greengram. M.Sc., (Agri.) Thesis. Tamil Nadu Agricultural University, Coimbatore,India.

Salam, S. A., M. S. Patil and P. M. Salimath. 2009. Evaluation of Mungbean cultures against MYMV in Karnataka under natural conditions. *Legume Research*, **32**(4):286-89.

Shad, N., S. M. Mughal, K. Farooq and M. Bashir. 2006. Evaluation of Mungbean germplasm for resistance against Mungbean Yellow Mosaic Begomovirus. *Pakistan Journal of Botany*, **38**(2):449–57.

Singh, A. K., S. Singh, V Prakash, S. Kumar and S. Dwivedi. 2015. Pulses production in India: present status, bottleneck and way forward. *Journal of Agrisearch,* **2**(2): 75-83.

Swathi, M., and N. Gaur. 2017. Effect of Border Crops and Insecticides on Management of Whitefly, *Bemisia tabaci* (Gennadius) Transmitted Yellow Mosaic Virus in Soybean. *International Journal of Current Microbiology and Applied Science,* **6**(5):613-617.

Tsai, W., S. Shih, A. Rauf, R. Safitri, N. Hidayati, B. Huyen and L. Kenyon. 2013. Genetic diversity of legume yellow mosaic begomoviruses in Indonesia and Vietnam. *Annals of applied biology,* **163**(3):367-377.

Usharani, K., B. Surendranath, Q. Haq and V. Malathi. 2004. Yellow mosaic virus infecting soybean in northern India is distinct from the species infecting soybean in southern and western India. *Current Science*, 845-850.

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