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Editorial - Volume 10, 2016

This is the tenth Volume of the OUSL Journal, the Journal of the Open University of Sri Lanka. The articles published in this volume include research based on floriculture, agriculture, education and social sciences by academics in a number of universities in Sri Lanka and Nigeria. This year we have received an excellent response from our readers and thirty full papers covering many subject areas have been submitted from researchers in Sri Lanka, Nigeria and India. We hope to publish our Journal biannually thus; other articles will be published in the Volume 11.

At present, due to various reasons, both parents are forced to work full time or part time to meet the obligations of their family lives. Apart from day-to-day house work of cooking, cleaning, shopping, and bringing up of their children, female academics engage in teaching, setting questions, marking answer scripts, research, supervising undergraduate/postgraduate students and carrying out administrative work. The first research paper by Oludeyi and Olajide titled "Occupational wellbeing among female academics; the influence of family-work interface" examines the influence of work-family interface on occupational and general wellbeing of women in academia. Research findings suggest that work-family interface significantly correlates with, and influences both occupational and general wellbeing of female academics. It also suggests that efforts should be geared towards formulating a policy to balance work-family interface for women academics considering job sharing, compressed working hours, self-rostering, telecommuting, flexi-time, child-care assistance, and so forth.

Floriculture is a profitable industry in Sri Lanka having about 25% of the annual export earnings. *Dendrobium* orchid has a good demand in the export and local market due to its vivid and variable flower colouration. Weerahewa, in her research article, focuses on improving floricultural quality, growth and enhancing disease resistance of *Dendrobium* by preharvest application of soluble silicon. All 100 mg/L silicon treated plants either weekly or bi-weekly showed a higher shoot length, higher leaf length and number of leaves compared to controls. Plants grown in newly

developed aeroponics system and treated with 50 mg/L silicon weekly showed better floricultural quality traits such as a higher number of flowers per spike and greater spike length, while the 100 mg/L treatment showed greater spike thickness and greater flower length and diameter. Natural disease development was significantly lower in plants treated with silicon. Average leaf thickness and cuticle thickness were significantly higher in plants treated with silicon as was the total soluble phenol content.

Godawatta and De Silva, in their article, discuss the impact of different mulches on growth and yield of Red Okra (*abelmoschus esculentus*). This study showed that Red Okra plants exposed to temperature stress gave a harvest 37% higher than the pods grown under ambient temperature. As straw is freely available in the dry zone in Sri Lanka, farmers can use straw mulch successfully when the temperature stress is a limiting factor for higher productivity.

There are many parameters such as adsorption ability, catalytic activity, sensitivity and thermodynamic stability of materials that are important for gas sensing. Bandara *et al.*, in their paper titled "Effects of surface modification of n-Cu_2O/p-Cu_xS thin film heterostructures for enhanced liquefied petroleum (LP) gas sensing properties", report a novel mechanism to effectively detect LP gas based on surface modification through sulphidation followed by passivation of electrodeposited *n*-type cuprous oxide (Cu_2O). It was found that the sensitivity of LP gas detection can be improved by 48% at a relatively low sensing temperature of 45 °C. Thus, the sulphidation has caused LP gas molecules to interact with the film surface more actively with a 10 fold increase when compared to the maximum sensitivity of untreated Cu_2O films at 85 °C.

Sri Lanka has become the world's third largest tea exporter in the world. Sri Lankan Tea is famous for its signature taste and aroma. Kavish *et al.*, in their paper titled "Impact of inlet drying temperature in Endless Chain Pressure (ECP) dryers on the quality characteristics of leafy type of tea produced using different leaf standards", investigate the appropriate higher inlet drying temperatures in ECP dryers to assess the improvement of quality

characteristic of tea of seven grades (OP, OP1, PEKOE, FBOPF, FBOP, FBOPF1 and OPA). Results revealed that there was no significant difference in liquoring properties of made tea produced at higher drying inlet temperature (230 ^{o}F) when compared to 205 ^{o}F for the three different leaf standards of 40%, 50% and 60% of good leaves tested.

Human smuggling affects at least three countries such as the country of origin, transits, and destination. It has an impact on the international relations, security and economy of these countries. Kathirgamthamby, in her paper titled "Human smuggling– implications on rights of migrants: an examination from the standpoint of International Law", seeks to inquire into and examine the rights of smuggled migrants particularly giving special attention to United Nations Convention against Transnational Organized Crime 2000 (UNCTOC) and the Protocol against the smuggling of migrants by land, sea and land supplementing the United National Convention against Transnational Organized Crimes 2000 (Protocol). This study shows that the smuggling protocol focuses more on punishing the offenders rather than protecting the rights of smuggled migrants. Although UNCTOC and the smuggling protocol aim to protect the rights of smuggled migrants, the convention does not impose any legal obligation and the countries are free to take actions as they please.

This volume also includes the Convocation Address-2016 made by Prof. Asha Singh Kanwar, President and Chief Executive Officer of the Commonwealth of Learning. She emphasizes five forces, namely (i) the force of technology, (ii) the force of globalization, (iii) the force of demography and longevity, (iv) the force of society, and (v) the force of energy resources, which may change how we work in the future.

We welcome your suggestions for further improvement of this journal. We look forward to publishing your current research findings in our next volume.

Professor K. Sarath D. Perera
Editor in Chief/OUSL Journal

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Occupational Wellbeing Among Female Academics; the Influence of Family-Work Interface

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Abstract

There has been a plethora of research on work-life and work-family balance in Nigeria and across the globe, however there is still much to learn of the intersection between people's work and non-work life. This study examines the influence of work-family interface on occupational and general wellbeing of women in academia. A descriptive survey research design was adopted, with a researcher-designed set of questionnaires of reliability co-efficient of 0.72 obtained through Cronbach alpha methods. A stratified random sampling technique was adopted in selecting 220 participants from two tertiary institutions in Ibadan, Nigeria out of which 181 were used for data analysis. Frequency Count, Standard Deviation, Pearson Product Moment Correlation and Rank Order were used for data analysis. Findings revealed that work-family interface significantly correlates with, and influences both occupational and general wellbeing of female lecturers. It was suggested that efforts should be geared towards ensuring that work-family balance policy options (such as job sharing, compressed working hours, self-rostering, telecommuting, flexi time, child-care assistance, and so forth) are made for women academics. Such policies should prioritise work flexibility for female academics.

Keywords: Female academics, general wellbeing, occupational wellbeing, tertiary institutions, work-family interface

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Introduction

In traditional African society, work activities were carried out simultaneously with domestic activities at home. It was purely an agricultural system where the family was a unit of production and productions were made purposely for family consumption (Fajana, 2006: 10; Googins, 1991). In those days, and to an extent presently in some rural areas, labour services were rendered on family agricultural farms and no wages were paid. Extra farm labour was seldom hired and in such cases, payments were made in kind, rather than cash, *i.e.*, in terms of food, clothing and shelter (Fajana, 2006). There was division of labour as the father hunted for animals, the mother gathered fruits and vegetables, while the children handled house chores like sweeping, cooking and sometimes fetched water with the mother. The employer was the father and family head and was, at his discretion, all-in-all as he determined the reward system, recruitment, selection, promotion, and not necessarily based on merit or seniority. He provided food, housing and security for all the employees (mostly family members) and even determined when they would get married and to whom (Iwuji, cited in George, Owoyemi & Onokala, 2012).

However, with the advent of the industrial revolution and the ensued technological advancement, people left agricultural and family business for paid employment in factories that were located outside the home. Clark (2000: 748), posits that the more industrialized the market economy became, the more workplaces were created outside the home and the more organisations, other than families, were in charge of productions. This physical and temporary separation between work and family lives poses several challenges to modern day employees. Since work and family are now in different domains or spheres which influence each other, certain changes in the nature of work and society have now emerged and increased the burden and responsibilities which are placed upon individuals both at work and at home. The work-family dichotomy also leads to a number of anomalies which, according to Brief and Nord, cited in Clark (2000) include; increase in divorce rates, leading to a high number of single parents; growing female participation in the labour force; more part-time work; increased labour mobility, which distances them from social supports of nuclear and extended families; changing employee expectations indicating greater interest in quality of life outside work; and growing social value placed on the fathers' involvement in the home [p.249].

Resultantly, one of the issues at the front burner in today's business world and among researchers in business and organisational behaviour is finding a balance between work and family life (Anafarta, 2011: 168; Fapohunda, 2014: 72) such that work-life conflicts can be managed if not eliminated totally. This is why there has been a plethora of research on work-life and work-family balance in Nigeria (see Adisa, Mordi & Mordi, 2014; Akanji, 2013; Amazue, & Ugwu, 2014; Fapohunda, 2014) and a substantial amount of studies of same concern have been done across the globe, (see Ahmed, Muddasar & Perviaz, 2012; Anafarta, 2011; Arif, & Farooqi, 2014; Shujat, Cheema & Bhutto, 2011; among others). However, there is still much to understand about the intersection between people's work and non-work life. Specifically, a scanty number of studies have been targeted at investigating female employees whose domestic responsibilities seem weightier than of male counterparts. This study thus, builds on work-family border theory (Clark, 2000: 751) to examine how female lecturers address the changing nature of their work and family commitments throughout their life course and how such interface influences their wellbeing, both at work and in general.

Statement of the Problem

Apart from the enormous day-to-day tasks of teaching, formulating questions, marking scripts, attending to students as guardians, engaging in research, supervising undergraduate and postgraduate students, performing community service duties (such as heading units and being members of committees *etc*) within and outside the university or college communities by academics, the tripartite demand that academic jobs place on lecturers is enormous. An academic staff member must be a teacher, researcher and community service provider (Akinjobi, 2013: 21; Kuther, 2015). For the female academics, research reveals that most academics' time is taken mostly by research and writing that are usually done in evenings and weekends. This is time that women need to keep up their homes and raise their families (Kuther, 2015). Since it is a must that female academics do research to keep their jobs and earn tenure while completing essential domestic obligations, they juggle career needs, family responsibilities towards husbands and children, socio-cultural responsibilities to and relationship with relatives; society and personal recreation needs (Akinjobi, 2013: 21). To balance these multiple conflicting roles of being a professional, a mother, a house worker, among others, is a stressful but indispensable routine. When domestic work is coupled with a busy professional life, the workload can become burdensome, and it

increases significantly as she procreates. Consequently, they suffer from strange rashes, neck and back problems, rheumatoid arthritis, breast infections, asthma, lupus among others (Kuther, 2015).

Unfortunately, stressors are interactive and cumulative: the more stressors one experiences, the greater the likelihood of stress-related health problems (Kuther, 2015). It may degenerate into hidden injuries resulting from exhaustion, overload, insomnia, anxiety, shame, aggression, hurt, guilt and feelings of being out-of-place, fraudulence and fear of exposure within the contemporary academy (Gill, 2009:1). It is against this backdrop that a study of this kind becomes imperative, such that the following research questions can be addressed:

1. Is there a relationship between work-family interface and general wellbeing among academics?
2. Does the interface of work and family significantly affect the occupational wellbeing of female academics?
3. In what areas of general wellbeing does work-family interface have the highest or lowest influence?
4. In what areas of occupational wellbeing does work-family interface have the highest or lowest influence?
5. Do female academics in different higher institutions of learning differ in their perceptions about work-family interface and occupational wellbeing?

Literature Review

Occupation refers to a group of everyday life goal-directed activities which are associated with any life domain but not necessarily work, such as leisure, education, or self-care (Anabym, Jarus, Backman, & Zumb, 2010: 81). However, work activities take more (both physically and mentally) from individuals than other daily engagements which raises the question of workplace wellness more often than wellness in general aspects of life. Hence, the concept of occupational wellbeing has gained popularity over the past few years (CIPD, 2007:1) because it has been recognised as a key factor in determining an organisation's long-term effectiveness (ILO, 2009). Many scholars have attempted a conceptualisation of occupational wellbeing but the definitions, even though related, overlap significantly. According to ILO (2009) and Marie-Amélie, *et al.*, (2013:1) occupational wellbeing relates to all aspects of working life, from the quality and safety of the physical environment, to how workers feel about their work, their working environment, the climate at work and work organization. Whereas wellbeing is more than an avoidance of becoming physically sick, it involves creating

an environment to promote a state of contentment which allows (an) employees to flourish and achieve their full potential for the benefit of themselves and their organisation (CIPD, 2007: 4). Although this common and everyday view of occupations as work, employment, or one's chosen career rather than recognizing that occupations refer to everything that people do during the course of everyday lives has been criticised by recent scholars (Davis & Polatajko, 2010; Singh, 2014:24). To conceptualise occupational wellbeing in such perspective will amount to reducing it to 'workplace' wellbeing. Occupational wellbeing refers to the wellbeing derived from participation and engagement in meaningful and valued occupations which may include but is not exclusively limited to paid work (CAOT, 2007; Singh, 2014: 24). This is why occupational wellbeing is subdivided into two categories (workplace and general wellbeing) in this paper.

Dimensions of Wellbeing

It appears that wellness has varieties of domains (CIPD, 2007), categories, levels or types (Grebner, Semmer, & Elfering, 2005). Grebner, *et al.,* did a longitudinal research on working conditions which shows three types of wellbeing: general wellbeing, job-related wellbeing and spill-over from work to non-work domains. This categorisation is in congruence with that of the Black Dog Institute except that the latter's has more detailed and specific types of wellbeing. Researchers at the Institute came up with results indicating where an individual sits on the following four areas of occupational wellbeing: a) work satisfaction, b) organisational respect for the employee, c) employer care, d) intrusion of work into private life. Another set of scholars also categorised aspects of human wellbeing using different indices in different contexts. Ryff and her colleagues studied a general context, and came up with 'six-dimensional context-free model' of well-being (Ryff, 1989; Ryff & Keyes, 1995). These dimensions include: a) self-acceptance: a positive evaluation of oneself and one's past life; b) environmental mastery: the capacity to effectively manage one's life and the surrounding world; c) autonomy: a sense of self-determination and the ability to resist social pressures to think and act in certain ways; d) positive relations with others, expressed by, for instance, a genuine concern about the welfare of others; e) personal growth: the sense of continued growth and development as a person as well as openness to new experiences; and f) purpose in life: the belief that one's life is purposeful and meaningful and that one has something to live for.

This is context-free while a study on job-specific wellbeing by Warr (1994) reveals four dimensions of job-specific wellbeing to include: affective wellbeing, aspiration, autonomy and competence. These four dimensions are considered by Warr as *primary* while a *secondary* fifth dimension; 'integrated functioning' was added. The fifth dimension encompasses the four primary dimensions of wellbeing and reflects the person as a whole (Warr, 1994). The CIPD, (2007: 8) also developed five domains of occupational wellbeing to include: a) Physical wellbeing (whether an individual is healthy or sick); b) emotional wellbeing (whether an individual is contented or distressed); c) wellbeing on personal development (whether an individual is flourishing or demotivated); d) wellbeing on values (whether an individual is committed or disengaged); and e) wellbeing on organisation or work (whether an individual is prospering or failing). With its general and work-specific nature, wellbeing is understood to be best mixed with other aspects of personal life among which family is most significant. Hence, the study of family-work interface and occupational wellbeing is desirable.

Studies on Work-life Interface and General Wellbeing

A growing body of empirical studies now focus on wellbeing and its connection with other variables within and outside organisations. In the past two to three decades, many studies on workplace have concentrated on its connection or benefits to individuals, organisations and societies in general. The studies of Betsey & Justin, 2013; Böckerman, *et al.*, 2012; Cotton & Hart 2003; Dame, 2006; Davis & Polatajko, 2010; Graham, 2003; Marie-Amélie, *et al.*, 2013; Singh, 2014; Tehrani, *et al.*, 2012; Willmott & Haslam, 2007; Wood, 2010; among others, have all made efforts towards adding to our understanding of wellbeing. While the study of Dame (2006) examined the best way to manage workplace wellness to boost employee as well as business performance, studies of Böckerman, *et al.,* (2013) investigated variables like high management involvement and their influence on employee wellbeing. Various other scholars show connections between wellbeing and performance (Cotton & Hart 2003), productivities (Graham, 2003), job design (Wood, 2010), work-related stress, (Siti Aisyah, *et al*, 2012), income (Betsey, & Justin, 2013), burnout, (Singh, 2014) among others. A wide array of revelations has been made from the outcomes of these studies. Yet, there are only a few studies on wellbeing in connection to the concept of work-family interface especially among academia. Does it mean that the interface of work and family is so insignificant to people's wellbeing, or has it been a widely known phenomenon, that it does not need further empirical probing? For the sake of empirical

confirmation, it can be stated hypothetically that work-family interface may influence workers' wellbeing (research question 1):

> *Is there a relationship between work-family interface and general wellbeing among academics?*

Studies on Female Academics and Workplace Wellbeing

In spite of the recent public enlightenment and campaign for gender mainstreaming in paid work, work roles are still seen to be men's primary domain while women are still primarily responsible for the home and children (Doucet, 2000; Noor, 2003: 298; Windebank, 2001). The situation is worse in the African continent where patriarchy is more intense. The perceptive distribution of work roles is not likely to be given prominence at the place of work where men and women who earn the same amount are expected to undertake the same weight of tasks. This makes work-family roles of women more complex than men's. Studies of Noor (2003), accounted for a number of family-related and work-related roles (variables) that seriously undermine women's general wellbeing. However, the study was not carried out in the African context and it was not particularly focused on female, academics. Other studies that have given attention to female academics occupational wellbeing are either conducted in contexts foreign to Africa (see Kinnunen, Feld, Geurts & Pulkkinen, 2006; Schmidt & Umans, 2014) or are not with special attention on work-family interface (see Cusack & Numer, 2012; Daukantaitė, 2006; Hellsten, Martin, McIntyre & Kinzel, 2011; Mugweni, Mufanechiya & Dhlomo, 2011; among others).

While the study of Kinnunen, *et al.,* (2006), examined the negative and positive spill over between work and family as influenced by work-family interface among Finnish women, the study of Schmidt and Umans, (2014) investigated the experiences of well-being among female doctoral students in Sweden. Noor (2003) examined work-related and family related variables as they influence the wellbeing of British women in Malaysia; a context where patriarchy is not strongly practised as it is in Nigeria. These studies would have provided us with adequate information of work-family interface and occupational wellbeing of female academics if conducted in cultural areas where women roles are perceived to be dominant at home. Unfortunately also, while the doctoral study of Daukantaitė (2006), on middle-aged Swedish women's general Subjective Wellbeing focused on the importance of childhood factors, social circumstances, and personality, other studies on women wellbeing

in university work tried to relate wellbeing to job-related stress, personality, and burnout among College of Education lecturers (Salami, 2009) social support (Salami, 2009; Cusack & Numer, 2012), hopes and hiccups concerning promotion (Mugweni, *et al.*, 2011), academic track tenure, (Hellsten, *et al.,* 2011), among others. None of these empirical studies show connections between work-family interface and workplace wellbeing. The study of Asiedu-Appiah, Aduse-Poku, and Acheampong (2014), which examined work-life balance of female lecturers in the African setting (Ghana) related it with career progression and not workplace wellbeing. Mugweni, *et al.*, (2011) also investigated work-family conflict associating it with barriers to female lecturers' promotion and not on workplace wellbeing. However, in Nigeria, Ogbogu (2013) recently attempted a study of work-life balance among female academics in Nigeria but it was focused on job performance as the dependent variable. While the outcomes of these researches constantly demonstrated that work-family interface connects and affects certain aspects of female life, there is still much to understand about the intersection between female academics' job task/responsibilities and their wellbeing at work (workplace wellbeing) especially in the Nigerian context. This provokes the second research question:

> *Does the interface of work and family significantly affect* workplace *wellbeing of female academics?*

General/Context-free Wellbeing and Workplace Wellbeing

In the literature, especially on the dimension of wellbeing, it appears undeniable that general wellbeing (as in the first research question) is not the same as workplace wellbeing (as in the second research). While the formal encompasses all aspects of wellbeing (such as, financial wellbeing, occupational wellbeing, workplace wellbeing, physical wellbeing, emotional wellbeing, family wellbeing, community wellbeing, among others), the latter simply refers to the wellbeing derived from participation and engagement in meaningful and valued occupations which may include but is not exclusively limited to paid work (CAOT, 2007; Singh, 2014: 24). Rather than reckoning with a particular model, the present study dwells on these multidimensional aspects of wellbeing to develop a framework (see Table 1 for the categories of wellbeing) considered suitable for the objects, subjects and context of this study.

Table 1: Categories of wellbeing

Context-free or General wellbeing	**Job related wellbeing**
Self-acceptance: a positive evaluation of oneself and one's past life;	Physical wellbeing (whether an individual is physical health at work or often feel pain during and or after work);
Environmental mastery: the capacity to effectively manage one's life and the surrounding world;	Emotional wellbeing (whether an individual is contented or distressed at work);
Autonomy: a sense of self-determination and the ability to resist social pressures to think and act in certain ways;	Affective wellbeing (whether an individual has personal affection or passion for the work regardless of its distastes) it also includes job satisfaction
Positive relations with others, expressed by, for instance, a genuine concern about the welfare of others;	Wellbeing in autonomy and competence (whether an individual experience improvement in technical knowhow and professional understanding);
Personal growth: the sense of continued growth and development as a person as well as openness to new experiences;	Wellbeing in organisation or work (whether an individual earns organisational respect or gets adequate employer care at work).
Purpose in life: the belief that one's life is purposeful and meaningful and that one has something to live for.	Aspirational wellbeing/wellbeing in personal and occupational development (whether an individual is flourishing or demotivated on the job);
Family: the distance or closeness to friends and relatives	Collegial wellbeing (whether an individual is in good disposition and pace with other colleagues on the job)

What may be interesting in the context of the present study is to ask the fundamental question of how work-family interface positively or negatively influence each domain or dimension of occupational and general wellbeing, hence the *research question three and four:*

> *On what areas of general wellbeing does work-family interface have highest or lowest influence?*
>
> *On what areas of workplace wellbeing does work-family interface have highest or lowest influence?*

Method

Research design and procedure: This study adopts a descriptive survey research design; a set of questionnaires was used as instruments to collect data from the female academic staff about the influence of work-family interface on occupational wellbeing among them. To obtain data for this study, the researchers designed a set of questionnaires with a 7 point rating scale of work-family interface and occupational wellbeing. The reliability test of the instrument yielded reliability co-efficient of 0.72 obtained through Cronbach alpha methods. With the aid of two research assistants who were postgraduate students, a sample size of 220 female academics selected by stratified random sampling technique from two tertiary institutions. They are 117 from the University of Ibadan and 1wq from the Polytechnics Ibadan, Oyo State, Nigeria. In all, 201 questionnaires were retrieved giving a return rate of 91.4% but 181 were found useful for data analysis. The responses were scored and used to prepare a spread sheet on Microsoft Excel for computer analysis.

Data Analysis: The statistical techniques that were used for analysis of the data include the use of Frequency Count, Standard Deviation, Pearson Product Moment Correlation and Rank Order. The dependent variable was *occupational wellbeing* of female academics while the independent variable was the *interface of work to family life* of these women.

Participants: The mean age score of the participants was 36.70 years with a standard deviation of 4.50 ranging from 25 to 55 years. While 59% are married, 31.5% never married and 9.5% once married. The average number of years in service of participants was 10.6 years (S.D. = 5.60) ranging from 1 to 20 years. The highest educational qualifications of the participants varied: PhD (32.7%), M.Ed./M.A./M.Sc. (39.7%), B.Sc./B.A./B.Ed. (17.8%), Other qualifications (9.8 %). The current designation of the participants include 29 Assistant lecturers (16%), 59 Lecturers I-II (32.6%), 39 Senior Lecturers (21.5%), 28 Associate Professors (15.5%), and 26 Professors (14.4%)

Results

Findings are presented in tabulated form according to research questions.

Research question one: *is there a relationship between work-family interface and general wellbeing among academics?*

Table 2. Correlation between work-family interface and general wellbeing

Variables	**Mean**	**Std. Deviation**	**N**	**R**	**Sig**
Work-family interface	16.58	4.218	181	0.777	0.000(sig)
General wellbeing	16.52	6.048	181		

(p<0.01)

Research question two: *does the interface of work and family significantly affect workplace wellbeing of female academics?*

Table 3. Correlation between work-family interface and workplace wellbeing of female academics

Variables	**Mean**	**Std. Deviation**	**N**	**R**	**Sig**
Work-family interface	16.78	4.434	181	0.707	0.000(sig)
Workplace wellbeing	16.64	6.182	181		

(p<0.01)

Research question three: on what areas of general wellbeing does work-family interface have highest or lowest influence?

Table 4. Ranking of areas of general wellbeing according to intensity of influence by work-family interface

Areas of general wellbeing	**N**	**Min**	**Max**	**Mean**	**St. Dev.**	**Rank**	**Remarks (Level of influence)**
Self-acceptance	181	1	7	3.30	1.672	7th	Average
Environmental mastery	181	1	7	3.67	1.867	6th	Average
Autonomy	181	1	7	3.32	1.672	5th	Average
Positive relations with	181	1	7	3.78	1.971	4th	Average

others							
Personal growth	181	1	7	4.11	1.686	2nd	Highest
Purpose in life	181	1	7	4.06	9.106	3rd	High
Family life	181	1	7	4.21	2.186	1st	Highest
Overall general wellbeing	181	8	45	26.87	9.106		Average

Research question four: *on what areas of workplace wellbeing does work-family interface have highest or lowest influence among female academics?*

Table 5. Ranking of areas of workplace wellbeing according to intensity of influence by work-family interface

Areas of occupational wellbeing	**N**	**Min**	**Max**	**Mean**	**St. Dev**	**Rank**	**Remarks Level of influence**
Physical wellbeing	181	1	7	3.37	1.886	6th	Low
Emotional wellbeing	181	1	7	3.81	13645	3rd	Average
Affective wellbeing	181	1	7	3.33	1.535	7th	Low
Wellbeing on autonomy/competence	181	1	7	3.76	1.711	4th	Average
Wellbeing on organisation or work	181	1	7	3.89	1.766	2nd	Average
Aspirational wellbeing	181	1	7	4.17	1.939	1st	Highest
Collegial wellbeing	181	1	7	3.71	2.019	5th	Average
Overall workplace wellbeing	181	8	45	25.78	8.556		Average

Discussion of Findings

The study investigated the influence of work-family interface on occupational and general wellbeing of female lecturers in selected tertiary institutions in Ibadan south-western Nigeria. The analysis revealed that work-family interface significantly correlates with both occupational and general wellbeing of female lecturers. On general wellbeing, (first research question), the mean score of work-family

interface was 16.58 with standard deviation of 4.218 while general wellbeing based on the interception had a mean score of 16.52 and standard deviation of 6.048. Correlation is 0.777 which is significant at 0.01. This means that work-family interface has a significant positive correlation with wellbeing in general. This finding corroborates earlier finding of Noor (2003) which accounted for a number of family-related and work-related roles (variables) that seriously undermine women's general wellbeing. On workplace wellbeing (second research question), the mean score for the interface of work and family is 16.78 while workplace wellbeing based on this interface is 16.64. The correlation is 0.707 which is significant at 0.01 level (see Table three). It shows that the interface of work and family significantly affect workplace wellbeing of female academics. The more the task and responsibility of work intersects with family life, the more its effects intensify on their wellbeing at work. These findings build up to the existing body of knowledge advanced by previous other previous studies (such as Kinnunen, *et al.*, 2006; Schmidt & Umans, 2014) which investigated female academics' occupational wellbeing in contexts that are foreign to Africa. Earlier studies on occupational wellbeing among women have also examined its association with other variables such as job - related stress, personality, and burnout (Salami, 2009) social support (Salami, 2009; Cusack & Numer, 2012), hopes and hiccups concerning promotion (Mugweni, *et al.*, 2011), and academic track tenure, (Hellsten, *et al.,* 2011). The current finding suggests a new determinant factor (work-family interface) in occupational wellbeing.

In Table four, the third research question was addressed. The area of general wellbeing where work-family interface has highest influence is family life which has a mean score of 4.21 amounting to 60%. The interpretation is that the distance and/or closeness to one's family and the extent to which one is responsible at home is the most affected by the interface of job to family life. This finding confirms the postulations of Brief and Nord, cited in Clark (2000) that work-family dichotomy affects family life such that it leads to increased divorce rates, leading to a high number of single parents; increased labour mobility, which distances them from social supports of nuclear and extended families; and growing social value placed on fathers' involvement in the home [p. 249]. After family life, an area of general wellbeing where work-family interface has the second highest influence is on their personal growth with a mean score of 4.11 which amount to 58.7%. Personal growth being the sense of continued growth and development as a person as well as openness to new experiences in life, has some consistence with recent findings of Asiedu-Appiah, *et al.* (2014: 426) which suggest that family-work

conflicts have a negative effect on the career progression of female lecturers. Following this finding, it appears that whatever affects career progression or personal growth affects overall purpose in life. This is probably why the third area of general wellbeing where work-family interface has the highest influence is their purpose in life. Purpose in life is defined as the belief that life is purposeful and meaningful and that female lecturers have something to live for. In other areas of general wellbeing, work-family interface has an average level of influence.

The last research question was addressed in Table five; the area of workplace wellbeing where work-family interface has highest influence is on aspirational wellbeing with a mean score of 4.17 (59%). Aspirational wellbeing means wellbeing in personal and occupational development: whether an individual is flourishing or demotivated on the job. This finding is very crucial and critical and consistent with our findings on *personalgrowth* (under general wellbeing) with a mean score of 4.11 which amount to 58.7%, an area where work-family interface has the second highest influence (see Table 4). This finding is meaningful because previous studies (see Mugweni, *et al.*, 2011; Akinjobi, 2013; Asiedu-Appiah, *et al.*, 2014) have demonstrated that work-life conflict has negative effects on the career progression of female lecturers. A majority of the respondents in the study of Asiedu-Appiah and his colleagues agreed that combining family and work-life affect female lecturers' ability to pursue further studies and publication. Their aspiration and ability to flourish at work is badly affected because academic qualification and research productivity are a major factor in career progression. In the same perspective with current findings on aspirational wellbeing, the study of Akinjobi, (2013: 21) revealed the challenges facing female academics such as juggling career needs with family responsibilities towards husbands and children, socio-cultural responsibilities to and relationship with relatives; society and personal recreation needs, which seriously undermine their research productivities and ability to progress. The present findings also corroborate the findings of Mugweni, *et al.*, (2011) which suggested that balancing work responsibility with the domestic role of female lecturers is one of the barriers and hiccups for rising to top leadership positions in universities. Asiedu-Appiah, *et al.*, (2014: 426) also found 72.1% evidence that childbearing and child care negatively conflict with the job progression of female lecturers.

Except aspirational wellbeing, work-family interface has average effect on other areas of workplace wellbeing which include: wellbeing on organisation or work, whether an individual earns organisational

respect or gets adequate employer care at work (55%); emotional wellbeing, whether an individual is contented or distressed at work (54%); wellbeing in autonomy and competence, whether an individual experiences improvement in technical knowhow and professional understanding (53.5%). The area of workplace wellbeing where work-family interface has the lowest level of influence is affective wellbeing with a mean score of 3.33%. The possible explanation of the low level of work-family influence on affective wellbeing is because, where it is affective, an individual is passionately committed to the work based on personal affection or drive which may neutralize the adverse effect of work-family interface.

Conclusion and Recommendations

Female academics' aspiration and ability to flourish at work is badly affected as work-family interface undermines their ability to pursue further studies and publications. They are grievously disadvantaged because the interface of work and family is found to affect their relationships with friends and members of their immediate families, while distancing them from their domestic responsibility and social supports from friends, relatives and possibly extended family members.

Based on these findings, it is recommended that government, university administrators and management alike, men whose wives are academics should bear in mind that the interception of work to family life has grievous effect on female lecturers' wellbeing both at work and in their general life. As such efforts should be geared towards ensuring that a work-family balance policy is crafted for women academics, especially those married who are in the process of procreating. Such policies should place top priority on 'work flexibility' and ensure adequate quality of working life for female academics. A number of work-life balance options may be incorporated into such policies. Such options include job sharing, compressed working hours, self-rostering, telecommuting, flexi time, child-care assistance, among others (see Fapohunda, 2014: 75).

The area of general wellbeing where work-family interface has highest influence is family life, as revealed in this study. There is, therefore, an urgent need for public campaign and enlightenment about gender mainstreaming in the perception and distribution of family responsibility. It is also important that, in the family institutions, women's homework, which includes but is not limited to child rearing and caring, cooking, housekeeping and other

domestic responsibilities of women should be evenly divided between men and women, especially if they are both in paid employment. The perception that paid work is mostly men's primary domain, while women are perceived to be primarily responsible for the home and children should be corrected with immediate effect.

Whatever affects career progression or personal growth affects overall purpose in life, and the intersection between work and family life of female lecturers seriously undermines their career progression. These adverse effects can be mediated through various empowerment programmes or units targeted towards women in academia. These empowerment programmes or units, established in each campus, should consider first priority to expand job and career prospects for women academics for professional growth in teaching and research as well as personal development (aggrandisements.)

It is also pertinent to say that this study focused only on two tertiary institutions in Ibadan south western, Nigeria. Future studies may expand its scope to cover more state and federal institutions across south western region. It will also be useful to investigate and quantify the perception of female lecturers in universities as compared to those in polytechnics and colleges of educations in Nigeria. Future studies may also explore, compare and contrast the work-family balance policies that are most effective in reducing work-life conflict among women academics. Such studies may distinguish policies that are most effective in universities from those that are effective in polytechnics or colleges of education.

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Floricultural Quality Traits and Probing Mechanisms of Silicon Mediated Disease Resistance of *Dendrobium*

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Abstract

Dendrobium sp. (Orchidaceae) is the most 'in demand' cut flower in the export and local market due to its vivid and variable flower colouration. However, the production of quality flowers is a major obstacle and is the main factor contributing to the export potential of the cut flower industry in Sri Lanka. This research was focused on improving floricultural quality, growth and enhancing disease resistance of *Dendrobium* by preharvest application of soluble silicon.

The experiments were conducted in a mesh house at 50% shade and were designed as a Completely Randomized Design (CRD). Each treatment or control plant consisted of 12 replicates and the experiment was repeated twice. The orchid plants were potted in clay pots and provided with 100 mg/L of sodium silicate at weekly intervals, showed significantly higher shoot length, leaf length and number of leaves compared to silicon provided bi-weekly or in the controls. Plants grown in a newly designed aeroponic system and treated with 100 mg/L silicon weekly showed significantly improved floricultural quality traits: a higher number of flowers per spike and higher spike length, higher spike thickness and higher flower length and diameter compared to the plants treated at 50 mg/L or untreated plants.

Natural disease development of leaf spot disease was significantly lower in plants treated with silicon as compared to the control. The average leaf thickness, cuticle thickness and total soluble phenol

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content were significantly higher in plants treated with silicon. These results indicate that mechanical barriers in the form of cuticle thickness and leaf thickness contribute towards the reduction of disease development. Increased levels of total soluble phenols in leaves of silicon treated plants may be also contributing biochemically towards warding off disease.

Keywords: *Dendrobium*, floricultural quality, silicon, phenol, cuticle thickness

Introduction

Floriculture is a profitable industry in Sri Lanka earning about 25% of the annual export income. *Dendrobium* sp. (Orchidaceae) is the most 'in demand' cut flower in the export and local market due to its vivid and variable flower colouration. However, the production of quality flowers is a major obstacle to the export potential of cut flowers in Sri Lanka. The control of *Dendrobium* floral diseases is currently achieved by application of systemic fungicides. However, the prolonged use of fungicides causes development of tolerant strains to fungicides. Further, the existing chemical strategies to combat these diseases are very expensive, environmentally unsound and hazadous. Hence, this research focused on developing disease control measures through induction of natural disease resistance mechanisms. Natural disease resistance in *Dendrobium spp* was induced or enhanced using abiotic elicitors, such as silicon in order to suppress development of disease during the preharvest phase and improve the floricultural quality of flowers.

No reseach so far has been carried out to improve the floricultural quality and reduce diseases of *Dendrobium* plant/flower using non-hazardous methods. The potential benefits of silicon nutrition in plants are extensively studied worldwide. Some of these include: the enhancement of growth and yield (Ma, 2004; Datnoff *et al.,* 2001), reduced cuticle transpiration and increased tolerance to lodging (Ma & Yamaji, 2006). It was observed that in rice, silicon stimulates erect growth enhancing light capturing ability and increases photosynthetic rates (Ma *et al.,* 1989). Other benefits of silicon in abiotic stress environments can be listed as, reduced mineral toxicity, and enhanced drought and frost tolerance (Ma, 2004). When

considering biotic stresses, a number of studies showed that silicon alleviates pest and disease damages and powdery mildew in wheat (Belanger *et al.,* 2003), cucumber (Menzies *et al.,* 1992), anthracnose in capsicum (Jayawardena *et al.,* 2014a; Jayawardena *et al.,* 2014b ; Jayawardana *et al.,* 2015 & Jayawardana *et al.,* 2016), and anthracnose in tomato (Huang *et al.,* 2011 ; Weerahewa & David, 2015), Phythium root rot in cucumber (Cherif & Belanger, 1992) and Fusarium root rot (Safari *et al.,* 2012).

Defensive mechanisms enhanced by silicon are explained by various methods. Silicon has been proven to be effective in controlling various diseases and pests in many important crops via stimulating the plants forming a mechanical barrier against the infection at the infection site or producing antimicrobial compounds. Silicon deposited on the tissue surface acts as a physical barrier preventing physical penetration and/or making the plant cells less susceptible to enzymatic degradation by fungal pathogens. This mechanism is supported by the positive correlation between the Si content and the degree of suppression of diseases and pests. Resistance against penetration may be due to accumulation and polymerization of Si at sites of penetration (Kunoh & Ishizaki, 1975) and strengthening of cell walls (Kim *et al.,* 2002). Accumulation of Si on stems at infected sites of powdery mildew of *Arabidopsis*, made the plant more resistant against the pathogen, *Erysiphe cichoracearum* (Blaich & Grundhöfer, 1998). Further, Si accumulated and deposited beneath the cuticle forms a Si-cuticle double layer acting as a mechanical barrier against infections (Samuel *et al.,* 1991). Application of liquid potassium silicate suppressed conidial germination and appressorial formation of *Sphaerotheca aphanis* var. *Aphanis* which causes powdery mildew on strawberry (Kanto *et al.,* 2006).

Rodrigues *et al.* (2003) revealed that Si enhanced the accumulation of diterpenoid Phytoalexins in rice at infected sites, which controlled blast disease caused by *Magnaporthe grisea*. Defense response was induced by soluable Si in cucumber roots infected by *Pythium* spp. due to stimulation of chitinase activity and rapid activation of peroxidases and polyphenol oxidases. Glycosidically bound phenolics extracted from Si-treated plants displayed a strong fungistatic activity when subjected to acid or, β-glucosidase hydrolysis (Carver *et al.,* 1998).

Recent findings indicate that silicon supplimentation improved the quality of Gerbera (Savvas *et al.*, 2002), Roses (Ehret *et al.,* 2005), Helianthus (Kamenidou *et al.*, 2008), Sunflower and Zinnia (Kamenidou *et al.,* 2008, 2009).

The present research was carried out to investigate the effects of silicon supplementation and application time on growth parameters (stem length, leaf length and number of leaves), and some floricultural quality traits in flowers (days for anthesis, number of flowers per spike, flower size, length and diameter of spike) of *Dendrobium* orchids. The mechanism underlying the silicon on diseases was investigated by measuring the thickness of the cuticle and levels of phenols in the silicon treated leaves.

Materials and Methods

Plant Material

Healthy, mature, tissue cultured, *Dendrobium* plants (12 month old, *cv. Ckai brownderby-TDC-23*, and 18 month old cv. Sonia) bought from the orchid nursery at the Department of Agriculture, National Botanical gardens, Peradeniya were used in the experiments.

Plants were kept in a mesh house at the Open University of Sri Lanka, Nawala. The mesh house environment provided the required 50% shade by shade nets, and misting of water was done to maintain the required temperature (28 ^{0}C) and high humidity (80% RH) levels. The recommended NPK (20: 20: 20) levels of fertilizer (01 g/1L water) was provided bi-weekly.

Preharvest Application of Silicon

Application of silicon to potted orchid plants

Three sets of *Dendrobium* plants of *cv. Ckai brownderby*, each containing 12 plants, in clay pots containing charcoal and tile pieces were used for this study.

Silicon suppliments were provided by applying sodium silicate (Sigma Aldrich Inc. USA) as a spray (5 mL of solution per plant as a fine mist) using a 1 L spraying bottle. One set of 12 plants were treated with sodium silicate (100 mg/L) at weekly intervals. The second set of 12

plants with the same concentration of sodium silicate (100 mg/L) was applied bi-weekly. The third set of 12 plants was sprayed with only water and maintained as the control.

Application of Silicon to Plants Grown as an Aeroponics System

Eighteen (18) month old *Dendrobium* sp. (*cv.Sonia*) was transplanted in an aeroponics system as illustrated in Fig. 1. Eight plants were put into net pots incorporating charcoal pieces. Fertilizer (Standard NPK (20: 20:20) was sprayed as a mist into boxes every day for a period of 5 min thrice daily using pipe systems and electric pump (Fig. 1). Three boxes were connected to the nutrient tank containing the above fertilizer and the excess solution was recycled. The diagramic view of the one box connected to the nutrient tank is given below. Similarly, 2 other boxes (Box 2 and 3) were connected to the nutrient tank.

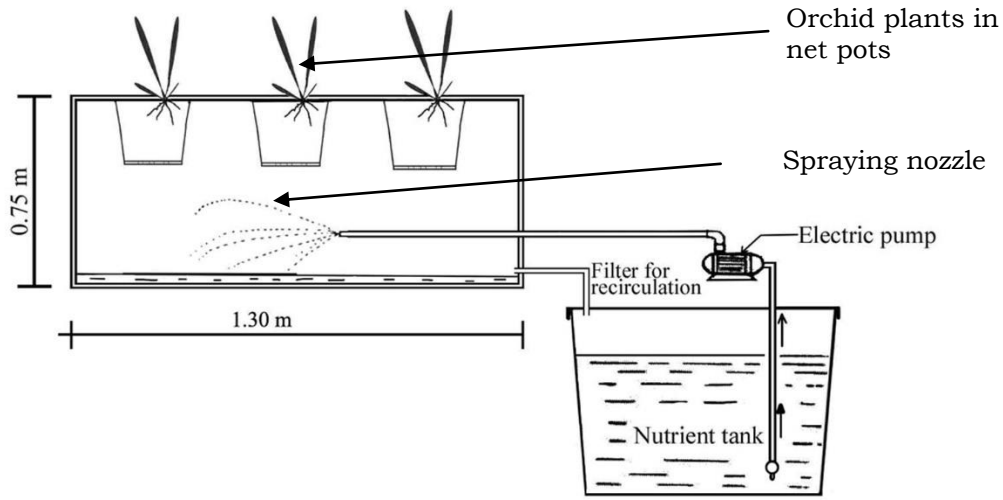

Figure 1. Newly designed (Digramatic view) aeroponics system for cultivating *Dendrobium*

Each box contained 8 plants and each plant in a specific box (Box 1) was sprayed with 50 mg/L of sodium silicate for 5 min. Plants in Box 2 with 100 mg/L of sodium silicate for 5 min and those in Box 3 were sprayed with water and maintained as the control. Silicon Treatment was given bi-weekly for a period of 12 months.

Effect of Silicon Supplimentation on Growth Parameters

Stem length, leaf length and number of leaves per plant were measured in *Dendrobium* plants treated with silicon as growth parameters and compared with that of the control plants. The stem length was measured from the base of the plant at the soil surface to the apex or tallest point of the plant. Leaf length was measured from leaf base to apex in the third leaf from the apex of each plant. The average value for each of the above parameters was calculated per treatment monthly for several consecutive months.

Effect of Silicon Supplimentation on Flower Quality Traits

Some flower quality parameters: days for initiation of buds, flowers, number of flowers per spike, flower size (length and diameter), spike length, spike diameter were evaluated for the plants treated with silicon and compared with control plants. Measurements were recorded as stated above.

Levels of Silicon in Silicon Treated Plants

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls (12 plants per each treatment) by analyzing molybdate reactive silica (SiO_2) by the molibdosilicate method using spectrometry (Clesceri *et al.,* 1998).

HCl (0.5 cm^3) and ammonium molybdate solution (1.0 cm^3) were added to 25.0 cm^3 of sample solution. The solution was mixed thoroughly and was allowed to stand for 5–10 minutes. Then oxalic acid (1.0 cm^3) was added to the same solution and was mixed thoroughly. The absorbance of the solution was measured at 410 nm after the addition of oxalic acid solution. The Si concentrations of the samples were measured by a plotted calibration curve using standard solutions (silicon) in the range of 4-12 mg/L. The blank (distilled water) was prepared in the same manner and the absorbance was measured.

Disease Resistance of Silicon Treated Plants

Preharvest Disease Development

Microscopic observations of diseased leaves showing characteristic

symptoms of cercospora leaf spot indicated the presence of *Pseudocercospora* sp. As repeated attempts to cutivate on Potato Dextrose Agar failed, medium enriched with *Dendrobium* leaf extracts was used for cultivation of the causal agent. This resulted in limited growth of the causal agent, however as colony diameter showed very slow development and as sporulation was not observed, artificial inoculation was not possible.

Hence, natural disease development of leaf spot disease was observed in silicon treated and non treated control plants (Each treatment composed of 12 plants) using a visual scale of diseased leaf area ranging from 1-100%. Each replicate plant was observed for diseased leaves and the average disease severity per plant was recorded on a weekly basis for a period of three consecutive months.

Histochemical Studies

The leaf and cuticle thickness in Silicon treated and non-treated control plants, (12 plants each from silicon treated and control) was measured using a stage micrometer and eye piece graticule (Graticules Ltd.) by observing under the low and high power respectively of a light microscope (Micros, Austria).

Analysis of Phenol Compounds

Total soluble and cell wall bound phenols in plant leaves were analysed using colourimetry (adapted from Ascensao and Dubery, 2003). Leaves showing 25% natural disease development were selected and assayed inorder to investigate the induced phenolics.

Total phenol levels

Fresh plant leaves (12 per each treatment) were ground in 80% Methanol (two grams fresh weight in 10 mL) and centrifuged at 3000 rpm (HITACHI-HIMAC) for 10 minutes. The supernatant was filtered through Whatman No.1 filter paper and used for analysis of total soluble phenols while the residue was used for analysis of cell wall bound phenolics. An equal volume of 50% Folin-Ciocalteu reagent (v/v) was added to 2 mL of the filtrate, mixed well and left for about 3 minutes. An equal volume of Sodium carbonate (7.5%) was added to the above mixture and left to stand for 1 hr at 25 ºC. Any resultant particles were filtered off and absorbance was measured at 765 nm using a UV visible spectrophotometer (Model Labomed UVD

3000/3200, USA) (Ascensao and Dubery, 2003).

Cell Wall Bound Phenol Levels

The residue obtained as above was dried at 70 ºC for 24 hrs to obtain the alcohol insoluble residue (AIR). The AIR was suspended in 0.5M NaOH (1 mL/10 mg) and left for 1 hr at 96 ºC. The supernatant was acidified to pH 2 with HCl and centrifuged at 3000 rpm for 10 min. The supernatant was extracted into an equal volume of anhydrous diethyl ether. This extraction was repeated two more times, pooled, evaporated to dryness and then resuspended in an equal volume of 80% methanol and subjected to the Folin assay described above. Absorbance was measured at 765 nm (Ascensao and Dubery, 2003).

Results and Discussion

Effect of Silicon Supplementation on Growth Paramenters

Shoot Length

All plants either weekly or bi-weekly treated with 100 mg/L silicon showed a higher shoot length compared to controls. Plants treated with silicon bi-weekly showed the highest value compared to plants treated weekly with silicon or non treated control. The lowest shoot length was observed in non treated control plants. A significant increase in stem height of plants treated with silicon was observed compared with the control plants. However, there was no significant difference between the stem height of plants sprayed with silicon at weekly intervals and bi-weekly.

Leaf Length and Number of Leaves

Plants treated with silicon either weekly or bi-weekly showed a higher leaf length and number of leaves. The highest was observed in plants treated with silicon at weekly intervals. However, no significant difference in the values of leaf length and number of leaves was observed in treated plants compared with the controls. Silicon treament given at weekly intervals had more impact on increasing the leaf length and number of leaves of *Dendrobium* Orchids. It has been recorded by Vendrame *et al.* 2010, that the application of $KSiO_3$ affect overall growth of *Phalaenopsis* orchid lines and increased fresh weight and dry weight of root shoot and whole plant over the controls.

Effect of Silicon Supplimentation on Floricultural Quality Traits

The lowest time was taken for intiation of buds (24 months) and flowers (25 months) in orchid plants treated with silicon at 100 mg/L weekly intervals. This was significanly different with the plants treated with silicon at bi-weekly intervals and non treated plants with silicon (Table 1).

There were significanly a higher number of flowers (14) in a spike in plants treated with silicon at weekly intervals compared to plants provided with silicon at bi-weekly intervals (flowers in a spike -11) and in non treated controls. The highest length and diameter of flowers (9 cm, 7.4 cm) was observed in the plants provided with silicon at weekly intervals. The plants recieving silicon bi-weekly, the length and diameter of flowers were 8.2 cm, 6.2 cm or in non treated controls, where these were 8.5 cm and 6.0 cm.

Similarly, the orchid plants provided with silicon at weekly intervals have shown significantly a higher length of the spikes (63.20 cm) and diameter (3.07 cm) compared to the plants provided with silicon bi-weekly (spike length-58.70 cm: diameter-1.97 cm) or non treated with silicon (spike length-59.16 cm: diameter-1.96 cm). It can be concluded that Silicon treatment given at weekly intervals had significantly improved the floricultural quality parameters; early bud and flower intiation, increasing the number of flowers in a spike, diameter, length of flowers, thicker spike thickness and length of *Dendrobium* flowers compared to the plants treated bi-weekly with silicon (100 mg/L) or non treated control plants.

Similar observations have been recorded in sunflower and Zinnias by Kamenidou *et al.,* 2008 & 2009. The diameter of sunflower was significantly increased and flowers had thick straight stems, and increased plant height when silicon was applied as sodium or potasium silicate to the plants as root drenches or foliar spray. The basal stem diameter of 'Zinnias' was also increased when Potassium silicate was applied as a weekly drench at 100 mg/L.

Savvas *et al.* 2002 also reported that crop quality of Gerbera improved

by having thick stems and quality flowers. Similary, Kamenidou *et al.* 2010 also recorded that Gerbera produced thicker flower pedancles, increased flower diameter, increased height and flowered earlier when treated with sodium silicate. The silicon treated roses also possessed thick stems when treated with silicon (Ehret *et al.*, 2005). All these finding are in agreement with the present study on effects of silicon in improving the floricultural quality traits of *Dendrobium* orchids.

Preharvest disease caused by *Pseudocercospora* sp was reduced by over 60% in *Dendrobium* plants treated with 100 mg/L weekly intervals than the plants treated with 100 mg/L Silicon at bi-weekly intervals or non treated control plants (data not shown).

Table 1. Effects of silicon supplimentation on floricultural quality

Treatments	Months for anthesis	Month for Flower initiation	No of Flowers	Flower Length (cm)	Flower diameter (cm)	Spike length (cm)	Spike thickness (cm)
Silicon (100 mg/L) weekly	24[a]	25[a]	14.40[a]	9.00[a]	7.40[a]	63.10[a]	3.07[a]
Silicon bi-weekly	25[b]	26[b]	11.20[b]	8.20[b]	6.20[b]	58.70[b]	1.97[b]
Control	25.6[b]	26.6[b]	11.00[b]	8.5[b]	6.00[b]	59.16[b]	1.96[b]

Different letters denoted by supercripts indicate the significant difference at P ≤0.05 from the Duncan Multiple Range Test.

Table 2. Effect of different levels of silicon on floricultural quality

Treatment	No of flowers	Flower Length (cm)	Flower Diameter (cm)	Spike length (cm)	Spike Thickness (cm)
50 mg/L	5.2[a]	8.0[a]	7.2[b]	23.5[a]	1.6[a]
100 mg/L	8.9[b]	8.5[b]	7.8[a]	32.5[b]	2.8[b]
Control	5.5a	7.8a	7.2a	26.6a	1.6a

Different letters denoted by supercripts indicate the significant difference at P ≤0.05 from the Duncan Multiple Range Test.

Levels of Silicon in Silicon Treated Plants

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls, using spectrophotometry. However, an increase of silicon levels of root or shoot or leaves was not observed in silicon treated plants compared to the control. The analysis of silicon of plant material was done to quantify presence of molybdate reactive silica (SiO_2) and this form of silica may not be the silicon present in the treated plant. Therefore, results obtained from this experiment had no any effect with the silicon treated and control plant.

Effect of Silicon Supplimentation on Orchids Cultivated in Aeroponics System

Dendrobium cv. *Sonia* grown in the aeroponics system treated with silicon either 50 mg/L or 100 mg/L were shorter than the control. The lowest height was observed in the plants treated with Silicon at 50 mg/L. Silicon treated plants grown in the aeroponic system showed an average higher number of flowers per spike, greater spike thickness and longer spike length compared to untreated control and plants treated with 100 mg/L silicon levels.

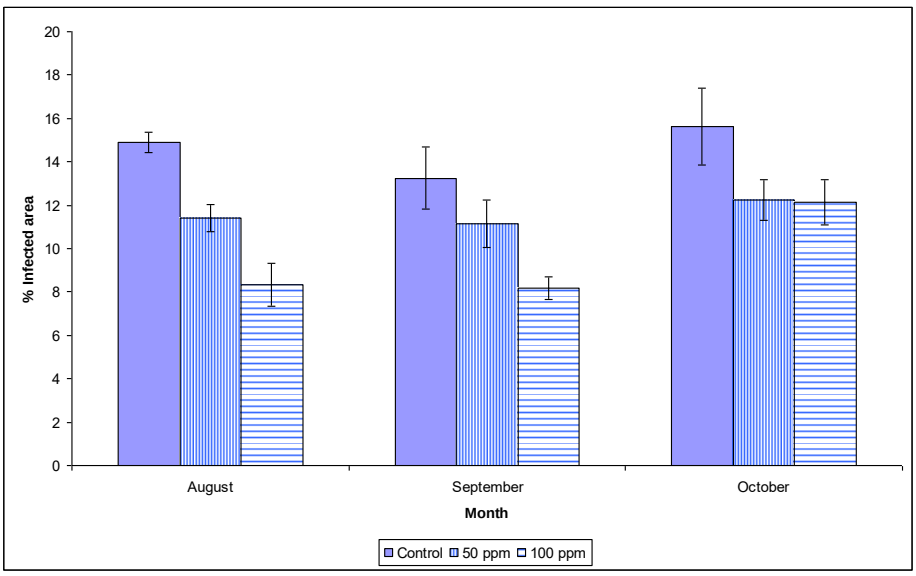

Figure 2. Natural disease development (Leaf spot disease) as shown by % infected leaf area in silicon treated and control plants.

Effect of silicon on Disease Development of Leaves

Natural disese development of leaf spot disease was lower in silicon treated plants as compared to the control throughout the period of evaluation. The lowest disease development was recorded in the 100 mg/L silicon treated plants.

Table 3. Effect of Silicon on leaf and cuticle thickness of *Dendrobium* orchid

Treatment	**Average leaf thickness** (mm)	**Average cuticle thickness** (µm)
Control	0.9±0.05	15.75±1.20
50 mg/L	1.12±0.04	20.6±1.28
100 mg/L	1.22±0.06	23.42±1.22

The results indicate that leaf thickness and cuticle thickness are significantly higher in silicon treated plants when compared with the control. The effect of silicon on cuticle and leaf thickness increased with the increase in silicon concentrations.

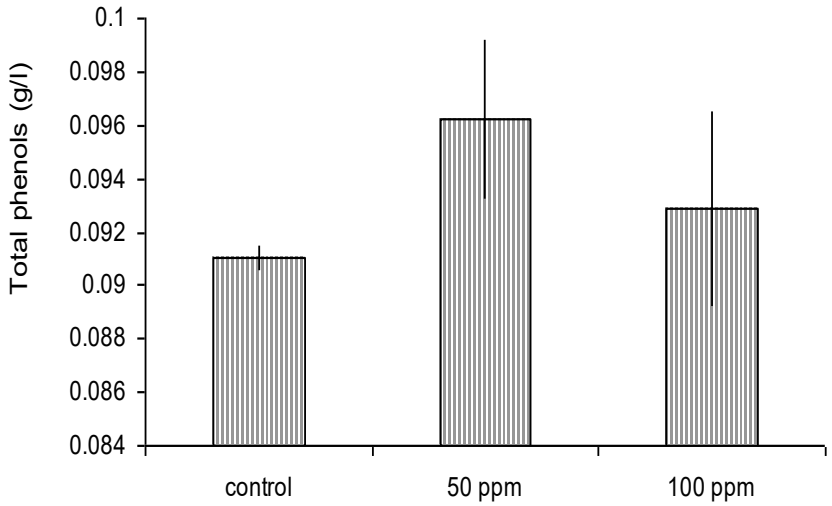

Figure 3. Total soluble phenol content in plants grown in the aeroponic system and treated with varying concentrations of silicon

The total soluble phenol content was higher in both silicon treated at

50 mg/L or at 100 mg/L silicon treated plants when compared with control plants. Among the treatments, the total soluble phenol content was higher in the 50 mg/L treatment. Contrastingly, the cell wall bound phenol content was lowest in the 50 mg/L silicon application (0.033 g/l ±0.0006) while the control and the 100 mg/L treatment gave higher values of 0.048±0.005 and 0.044±0.007 respectively.

Conclusions and Recommendations

All 100 mg/L silicon treated plants either weekly or bi-weekly showed a higher shoot length, higher leaf length and number of leaves compared to controls. Silicon treatment given at weekly intervals had significantly improved the floricultural quality of *Dendrobium* flowers compared to the plants treated bi-weekly with silicon (100 mg/L) or non treated control plants.

Plants grown in aeroponics system and treated with 50 mg/L silicon weekly showed better floricultural quality traits such as a higher number of flowers per spike and greater spike length, while the 100 mg/L treatment showed greater spike thickness and greater flower length and diameter. The overall observation during research was improved floricultural quality traits: a higher number of flowers per spike and higher spike length, higher spike thickness and higher flower length and diameter of *Dendrobium*.

Natural disease development, leaf spot disease was recorded as, percentage of leaf showing disease symptoms. Natural disease development was significantly lower in plants treated with silicon as compared to the control. This trend was observed consistantly throughout the three months of disease evaluation. Average leaf thickness and cuticle thickness were significantly higher in plants treated with silicon as was the total soluble phenol content. These results indicate that mechanical barriers in the form of cuticle thickness and leaf thckness contribute towards the reduction of disease development. Increased levels of total soluble phenols in leaves of silicon treated plants may be also contributing biochemically towards warding off disease. However, significantly higher levels of cell wall bound phenols were not observed in silicon treated plants in this study.

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Impact of Different Mulches on Growth and Yield of Red Okra (*abelmoschus esculentus*) Indigenous Variety Exposed to Temperature Stress

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Abstract

Understanding the effect of temperature and water stress on growth and yield of crops, and also identifying suitable soil and water management options to sustain the productivity under unexpected changes in the natural environment due to global warming are of timely important. Therefore, the objective of this study is to assess the effect of mulching on soil properties, growth and yield of Red okra (indigenous variety) plants exposed to induced temperature stress to mimic global warming. Experiment was conducted in a temperature regulated poly tunnels with 34°C and in the open field with ambient temperature 28-30 °C. Coir dust, straw and saw dust were used as mulch types.

Plants were watered to the field capacity daily to minimize the water stress conditions. According to the results, sawdust mulched soil maintained a neutral pH even at stressful temperature. In temperature stress, sawdust mulch maintained the highest electrical conductivity; it would have enhanced the cooling effect on Red Okra plant roots. Further, the significantly highest plant height was observed in saw dust and straw mulched plants under stressful temperature which improved the vegetative growth of the plants. The highest number of flowers (10) was obtained in straw and saw dust mulched treatments followed by coir mulch (9). The lowest number of flowers was obtained in no mulch condition. Number of pods per plant too follows the similar pattern of number of flowers. However, significantly highest pod weight/yield was obtained at

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straw mulch (38 g) treatment in stressful temperature. When Green Okra (variety Haritha) was tested in the same poly tunnel with the same experiment conditions but without mulching in a previous season, it showed less number of flowers (8), pods (7) and pod weight (30 g) for stressful temperature treatments. Further, the Red Okra pods of 20 cm in length were harvested 5-6 days after flowering even though in ambient temperature, it took 7-8 days. The early harvest in stressful temperature, Red Okra pod yield was 37% higher than the ambient temperature treatment. But in Green okra (variety Haritha) the pods have to be harvested on 5-6 days in stressful temperature while the pods were just less than 10 cm which was not preferred by consumers as the edible part is small compared to a 20 cm long Red Okra pod. This study shows that using suitable mulch such as straw for Red Okra (indigenous variety) could be a viable adaptation measure for dry zone farmers in global warming conditions.

Keywords: Mulch, Temperature stress, Okra red, global warming

Introduction

The average annual temperature for 2050 using General Circulation Model (HadCM3) is predicted to increase by 1.6 °C for IPCC (2001) (A2) scenario) and 1.2 °C (B2) scenario). The highest mean temperature predicted for Anuradhapura is 2.1 °C (A2), 1.6 °C (B2). During the Southwest monsoon period (May to September), the overall increase in mean annual air temperature across the island is predicted to increase by 1.6 °C (A1) and 1.2°C (B2). Agricultural activities in the dry zone may be affected by predicted climate change in Sri Lanka (De Silva, 2006).

Red Okra is an indigenous variety grown in Sri Lanka. Okra is one of the most popular and intriguing vegetables in the Mid-South United States. It not only adds variety, taste and nutrition to Southern cuisine, it is also one of the more reliable crops that farmers and gardeners can grow in a changing climate (Kuepper, 2008). Originating in the African continent, Red Okra is typically heat and drought tolerant, with only a small number of serious diseases and insect pests. Six to seven inches long, torpedo-shaped red or

burgundy colored Okra pods are tender and rather sweet tasting. Offering a unique flavor and texture, the fresh taste is somewhere between eggplant and asparagus. When cooked, however, the red color disappears and the pods turn green. Raw Red Okra adds a colorful touch to many dishes (Kuepper, 2008).

Red Okra is grown in Wet, Intermediate and Dry zones of Sri Lanka. Presently Red Okra is successfully cultivated in the districts of Hambantota, Kurunagala, Ratnapura and Matale. Also it is expanding in potential districts like Anuradhapura, Puttlam, Matara, Badulla and Moneragala (Department of Agriculture web site). Okra plays an important role to improve the palatability of many dishes and is generally used as nutritional supplements for vitamin C and A, B complex plus magnesium, potassium and calcium. It is fat-free, saturated-fat-free, cholesterol-free and low in calories. (Adebooye and Oputa, 1996).

In the previous study at the Open University with Green Okra (*Abelmoschus esculentus*) variety Haritha under three temperature conditions as 32 °C, 34 °C and ambient temperature with water stress and no water stress conditions but without mulching, there was significant effect of individual and combination stress of water and temperature on the growth and yield parameters such as plant height, fresh weight and pod length. Significant yield reduction was seen in the water stressed plants. Further temperature stress has especially affected the pod quality parameters such as fibre and pectin content. Harvesting time of Okra under ambient temperature was not suitable for the high temperature conditions due to rapid pod growth rate and break down of the calcium pectate in 5 to 6 days after full blooming. Water and temperature stress in combination had less negative effects on growth parameters as compared to the individual water stress treatments. The high temperature stress in combination with no water stress situation can increase the Green Okra (Variety Haritha) yield significantly compared with other treatments. But the constraints were that the pod has to be harvested in 5-6 days instead of 7-8 days and pods of 5-6 days are very small and not very attractive in the market. Further, under high temperature it is difficult to distinguish the

exact point for harvesting as the Okra pods quickly matured when it exposed to high temperature stress (Gunawardhana *et al.*, 2011). Therefore, in this study, Red Okra the indigenous variety, with three types of mulching was used to study the coping capacity to induced temperature stress. Red Okra is an indigenous variety the pods are red in colour, torpedo shaped and two to five inches long. It is also called as "Red Burgundy" which grows well in full sunlight and has a year around cultivation.

Materials and Methods

Growing conditions

This present study was conducted in the Agricultural field, of the Open University of Sri Lanka, Nawala, Nugegoda using a temperature regulated poly tunnel as one experiment unit. The poly tunnel was maintained at 34 °C maximum temperature. Second experiment unit was outside the poly tunnel in ambient temperature (28-30 °C). This study was conducted during 2013 November to November 2014. Temperature inside the poly tunnel was maintained (34°C) through an automated regulatory system.

This study intends to identify the suitable mulch to mitigate the consequences of higher temperature stress on soil by evaluating the growth and yield parameters of Red Okra indigenous variety. The pots were filled with 5 kg mixture of air dried reddish brown earth soil and compost. 3:1 ratio of soil and compost potting medium used for each pot. Reddish brown earth soil was from the Anuradhapura area (flat land scape) and the depth of the plough layer was 0-30 cm. Three types of mulches (Coir dust, straw and sawdust) were used as an average depth of 2.2 inches of layer spread on the soil surface along with a no mulch condition shortly after sowing (planting). Coir and saw were used as dust form and straw was used by cutting in to 2 cm of length. Spacing of pots for Okra was 90 cm x 60 cm as recommended by the Department of Agriculture. Determined parameters of the RBE soil (from Anuradhapura) as pH (1:2.5, soil:H_2O) 7.1, Clay (%) 27, Silt (%) 12, Sand (%) 61, OM (%) 1.5, K(ppm)160 and P(mg/kg) 20. Determined the parameters of compost

used for this research as pH 6.8, OM (%) 32 and conductivity (ms cm^{-1}) 720.

Plants were maintained without water stress by applying water to keep the soil moisture at field capacity. Individual plastic pots were filled with compost and reddish brown earth soil mixture. Three seeds were sown in each pot and seedlings were thinned to one plant for each pot 18-25 days after sowing (1 plant/ pot in 40 cm diameter and 45 cm deep pots). All the crop management and cultural practices were adopted according to the Department of Agriculture.

Figure 1. Pot arrangement of Okra

Table 1. Two different environmental conditions of the experiment

No	*Environmental conditions*
Condition 1 – Poly tunnel	34 °C Poly tunnel ● Three types of mulches on soil – coir dust (M1) /straw (M2)/saw dust (M3)/No mulch(M0)
Condition 2 – Open Space	28-30 °C Ambient temperature ● Three types of mulches on the soil – coir dust (M1) /straw (M2)/saw dust (M3)/No mulch(M0)

Temperature control in the poly-tunnels

The variation of temperature inside the poly tunnel and the ambient temperature outside over a period of 24 hours was observed as shown below (Figure 2). The temperature at night falls below the maximum temperature set for that particular poly tunnel to represent the diurnal variation. However, the temperature maintained inside the poly tunnels was always higher than the ambient temperature; therefore temperature stress was forced on the plants during day time while there was photosynthetic activity (Figure 2).

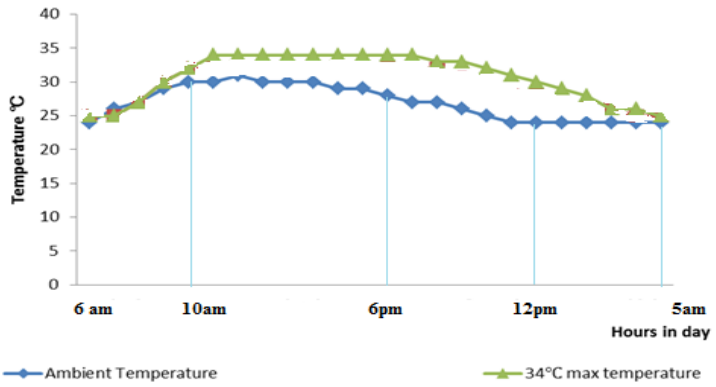

Figure 2. Temperature variations inside and outside the poly tunnel

Plant Growth Parameters

Plant growth parameters were investigated weekly during the study period. Data was recorded from the vegetative growth up to the fresh green tender pod yield. To obtain sample of pods of uniform maturity, blossoms were tagged with colored wool at the beginning of full bloom. Plant heights and number of flowers were determined by nondestructive sampling at a weekly basis during vegetative and flowering period of the crop. Germination percentage (Survival rate) was estimated by the percentage of plants that germinated from the seeds as follows:

$$\text{Germination percentage} = \frac{\text{No of Seeds Germinated}}{\text{No of seeds sown}} \times 100$$

Total number of flowers was counted following tagging method. Plant height was measured at weekly intervals up to 6 WAP from the surface of the soil to the tip of the highest leaf. The weight of pods developed from tagged flowers was measured. The length of pods developed from tagged flowers was measured using a ruler.

Soil sampling was performed twice every season of the experiment. First sampling was done 10 weeks after planting and, second sampling was done after crop harvesting. Soil samples were taken from 10 cm below the surface of each pot using a soil sampler. Composite samples were prepared accordingly and each pot has 3 composite samples. Soil pH and EC were measured preparing soil solutions using pH and electrical conductivity meter.

Data Analysis

The experimental design was Completely Randomized Design (CRD) with factorial treatment structure. Temperature and mulches were taken as factors. All extraction runs and analysis were carried out at least in duplicate and in randomized order with the mean values. For each treatment five replicates were used to deduce the random error. Analysis of covariance (ANCOVA) of the results was performed using General Linear Model procedure of Mini tab (Software Version

17) Multiple comparison of the various means were carried out by LSD

Results and Discussion

Soil Parameters

Soil pH

Average soil pH among the treatments ranged from 6.3-6.8 (Figure 4.). Average soil pH among the treatments ranged from 6.4-6.8 (Figure 4). Generally, plants mulched with saw dust and straw maintained near (6.7-6.8) to the neutral pH values than the others ($p < 0.05$). Soil pH is lowest in plants mulched with coir dust (6.4). In sawdust mulch, the pH was maintained at 6.8 which is near to the neutral pH even in the stressful conditions. Lower soil pH increases the solubility of A1, Mn and Fe which can be toxic and therefore, limit root growth. Neutral pH encourages the decomposition rate (Kemmitt *et al.,* 2005) and it is also the preferred soil pH range for good growth and optimum yield of common crops. It was reported that the best pH range for Okra is 6.5-6.8 (Kemmitt *et al.,* 2005).

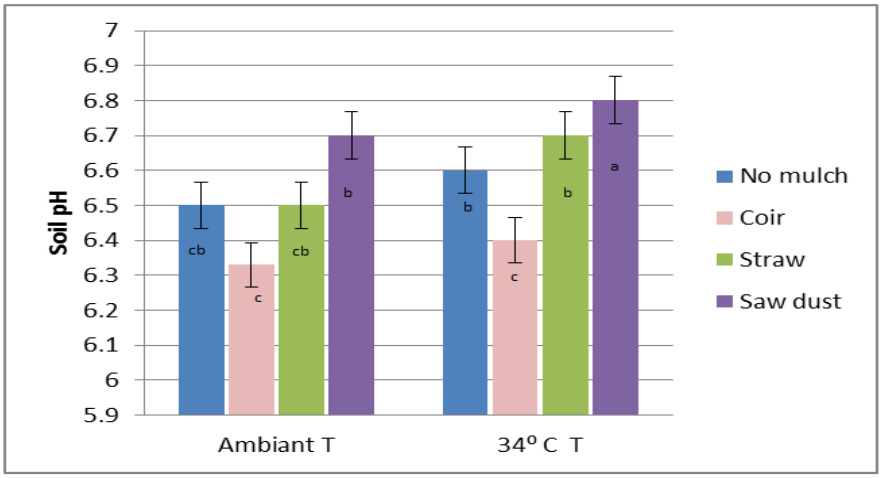

Figure 4. Effect of coir dust, straw and saw dust as mulch on soil pH

Soil Electrical Conductivity (EC)

Average soil EC among the treatments ranged from 0.07-0.09 dS/m (Figure 5). According to the results, EC decreases with increasing temperature. But there is a significant difference ($p < 0.05$) between mulched and no mulched treatments. The highest EC was reported from coir dust treatment in ambient temperature followed by straw and then saw dust mulch. In stressful temperature (34 °C) treatments, the lowest EC was shown from no mulch condition and the highest was obtained in saw dust mulch. Agricultural management practices can change the temperature of the soil surface and influence the hydrothermal properties of the soil. For example, mulching can affect the temperature and moisture content of the soil. EC is proportionally increased with the moisture content (Li *et al.*, 1999).

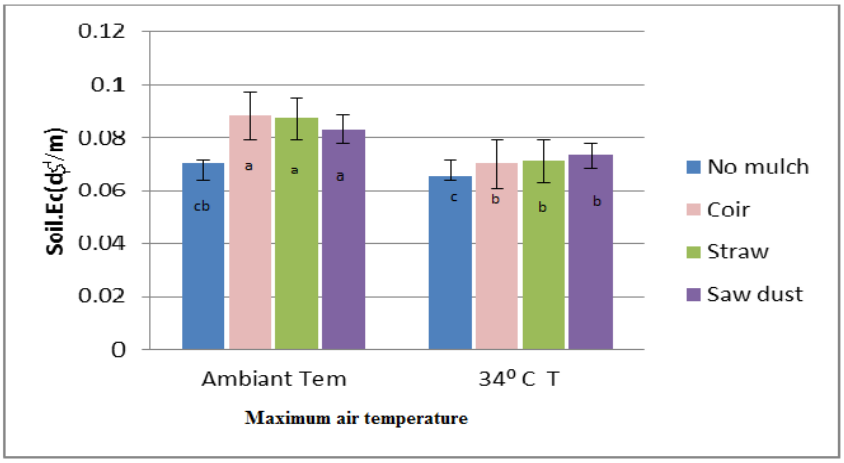

Figure 5. Effect of coir dust, straw and saw dust as mulch on soil electrical conductivity

Growth and Yield Parameters of Red Okra

Percentage of the Germination

Mulches significantly ($p < 0.05$) affected the germination of Red Okra seeds respective of the temperature. Seedling emerging rate was significantly reduced by no mulch condition in both temperature

treatments 2 weeks after seeding (Figure 6). Similarly, Sharma (1976) explained that limiting soil water content and extreme temperatures are the major stresses which constrain seed germination in arid and semiarid regions. Germination is the period which requires the highest water potential. Temperature also appears to determine the optimal and minimum water potentials for germination of several species (Sharma, 1976).

In addition, individual effect of the temperature stress has significant influence on the germination at 0.05 probability level. Temperature stress effect may reduce the probability of seedling establishment because of the effect of high temperature results in low soil water conditions, and the effect on seedling growth and survival of seedlings (Gunawardana *et al.,* 2011).

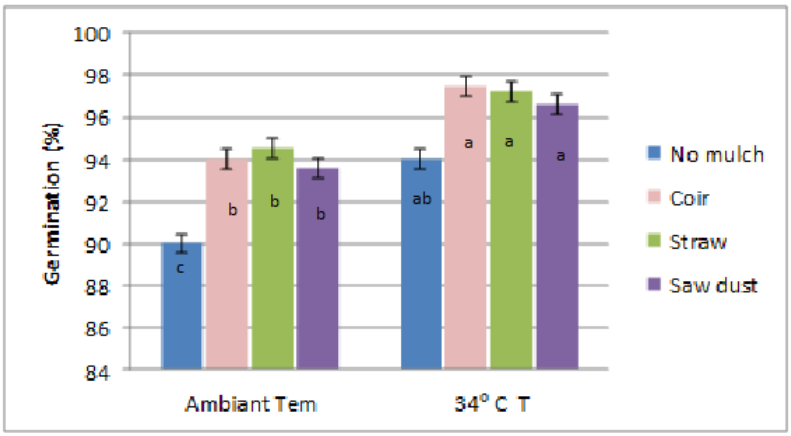

Figure 6. Effect of treatments on percentages of the germination

Plant Height

Average plant height among the treatments ranged from 64-74 cm (Figure 7). Generally, height of the plants maintained in 34 °C maximum temperature is significantly higher than that of ambient temperature ($p < 0.05$). High temperature induces rapid growth and therefore, the plant height is significantly high in plants grown in 34 °C maximum temperature poly tunnel which agrees with Ravinder *et al.*, (1997). Further, 34 °C maximum temperature poly tunnel height of the plants mulched with sawdust was highest followed by coir

dust and straw. Plants grown in no mulch condition was lowest in height.

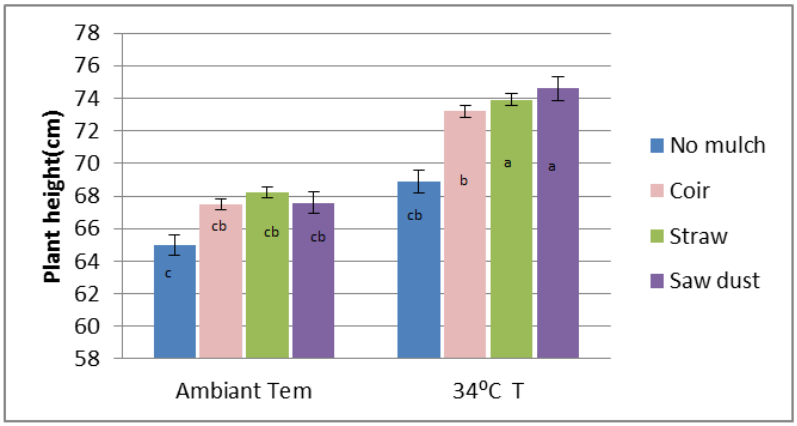

Figure 7. Effect of treatments on average plant height

Number of Flowers

The Red Okra started to flower 3, 4 weeks after sowing (Figure 8). Among the treatments, the number of flowers/plant was counted up to 3 weeks from the first flowering. The highest number (10) of flowers was observed in 34 ^{0}C temperature poly tunnel under saw dust and straw mulched condition, compared to no mulch (Figure 8). However, Green Okra variety *Haritha* produced only 8 flowers in 34 ^{0}C temperature without water stress condition (Gunawardena *et al.*, 2011). There was no significant difference ($p > 0.05$) in the number of flowers due to the effect of mulch. But the individual effect of temperature has significant influence except in no mulch and coir dust mulch condition according on the flowering. It showed that the Red Okra (indigenous variety) performed better than Green Okra (variety *Haritha*) experimented in the same condition under stressful temperature conditions without mulch treatments.

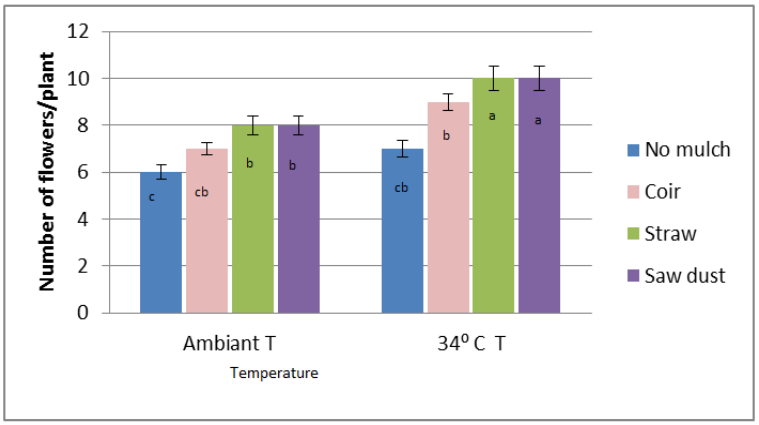

Figure 8. Effect of treatments on average number of flowers per plant

Pod lengths

Average pod length of Red Okra among the treatments ranged from 17.8 -21.2 cm (Figure 9). Pod length of the plants maintained in 34 °C temperature with coir and straw mulches are significantly higher than that of the others ($p < 0.05$). Pod length is lower in plants grown in ambient temperature than 34°C. However, pod length in plants mulched with coir dust and straw mulch were found to be greater than the other mulch types in stressful temperatures.

The pod length was increased slowly in the first three days of development, and then increased rapidly until the eighth day when those plants grow in the ambient environment. Similarly, Ketsa and Chutichudet (1994) showed that pod length increased rapidly until the eighth day. Pods showed rapid development when they were exposed to the high temperature stress with no water stress condition.

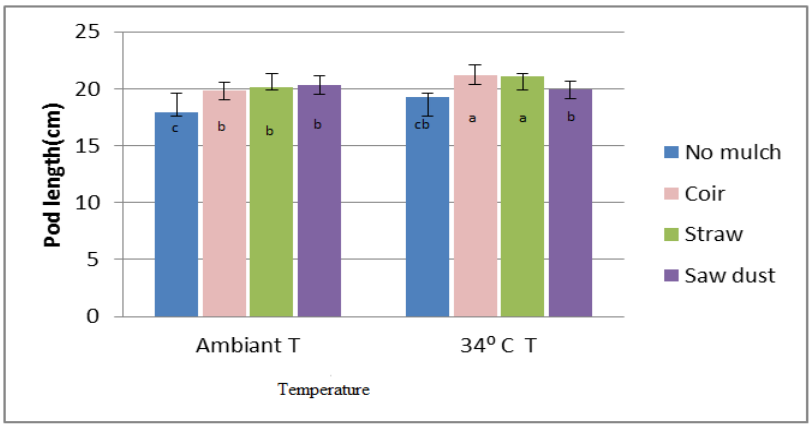

Figure 9. Effect of treatments on average pod length

Number of pods per plants

The highest number of fruit/ pod per plant (9) was found with high temperature (34 ^{0}C) with saw dust and straw mulches and the lowest number of pods was observed in no mulch condition at both high temperature (34 ^{0}C) and the ambient temperature treatments (Figure 10). But, the highest number of pods in Green Okra (variety Haritha) was less than 7 (Gunawardena *et al.,* 2011). Drought or temperature stress occurring during vegetative growth period is called the vegetative phase drought. This type of drought affects plant's assimilatory organs, which usually decrease in number and size as a result of lower photosynthetic production (Kaiser, 1987). This study shows that proper soil and water management even at stressful temperature can improve the number of pods/fruits per plant of Red Okra.

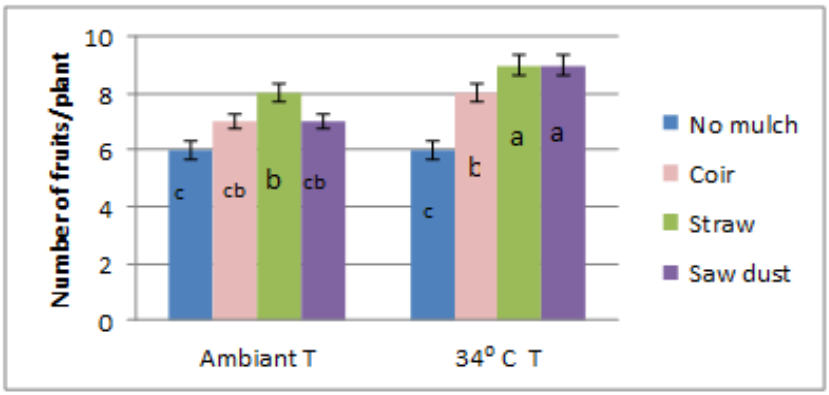

Figure 10. Effect of treatments on average number of fruits per plant

Pod Yield

The number of pod and pod weight are important yield components of Red Okra to achieve highest yield (Figure 11). Results indicate the effect of individual mulches on yield (Table 2). In Green Okra (variety *Haritha)* pod yield reduces proportionately with the temperature because variety Haritha produced pods less than 30 g of average weight (Gunawardana *et al.,* 2011). But in Red Okra, pod yield was high with mulch when it was exposed to 34 ^{0}C temperature comparing with no mulch condition. Highest yield of Red Okra was obtained in 34 ^{0}C temperature with straw mulch. Red okra reached the highest average pod weight of 38 g with straw mulch and 37 g in saw dust and coir mulches even at stressful temperature.

Further, the results of Red Okra showed that under ambient temperature, Red Okra pods could be harvested 7 to 9 days after full blooming. Whereas, when there is temperature stress such as 34^{0}C Red Okra pods could be harvested 5 to 6 days after full bloom when the pod length is about 20 cm which is a good marketable size. But in Green Okra (variety *Haritha)*, when there is temperature stress (34 ^{0}C) pods have to be harvested on 5-6 days but the length is less than 10 cm which does not attract a good market price. This study has shown that even in the Red Okra pods harvested earlier than normal in high temperature (34 ^{0}C), the yield was 37% higher than the pods grown under ambient temperature. This may be due to the fact that vigorous growth and development of Red Okra in the higher temperature conditions has lead to this production. It proves that Red Okra can perform well in stressful temperature by using mulches to resist the effect of high air temperature on soils. Cultivating Red Okra with straw mulch to ensure a higher number of pods and higher pod weight could be a valuable adaptation measure for farmers facing high air temperature stress due to global warming.

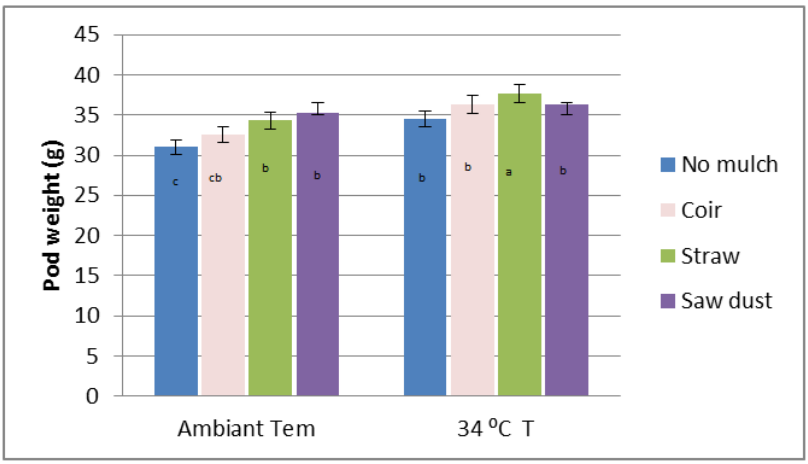

Figure 11. Effect of treatments on the average fresh pod weight

Table 2. Mean values of growth and yield parameters of Red Okra under deferent treatments.

Treatments	Pod weight (g)		Germination (%)		Plant height (cm)		Number f fruits		soil pH		Soil Ec	(ds/m)
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Ambient tem-no mulc	31	±0.38785	90	±0.215090	65	±4.733920	6	±0.215090	6.5	±0.063245	0.08	±0.224499
Ambient tem-coir	32.5	±0.24498	94	±0.425365	67.5	±2.416609	7	±0.425365	6.3	±0.332264	0.088	±0.256124
Ambient tem-straw	34.3	±0.01354	94.5	±0.389378	68.2	±3.852272	8	±0.389378	6.5	±0.666333	0.087	±0.292574
Ambient tem-saw dus	35.3	±0.00030	93.6	±0.244981	67.6	±4.319326	7	±0.244981	6.7	±0.025612	0.083	±0.116619
34 o c max tem-no mul	34.5	±0.31240	94	±0.076164	68.9	±4.720151	6	±0.002135	6.6	±0.630891	0.065	±0.332307
34 o c max tem-coir	36.3	±0.00580	97.5	±0.253574	73.2	±5.462600	8	±0.000303	6.4	±0.259729	0.07	±0.185472
34 o c max tem-straw	37.6	±0.285	97.2	±0.457537	73.9	±1.638883	9	±0.003124	6.7	±0.319183	0.071	±0.285
34 o c max tem-saw du	36.3	±0.21260	96.6	±0.145	74.6	±3.034798	9	±0.005805	6.8	±0.564269	0.072	±0.291260

Conclusions

According to the results, in stressful temperature (34 ^{0}C), neutral pH maintained in saw dust mulch improves the soil nutrient availability and root as acidic pH conditions create toxic conditions. Highest EC was observed in stressful temperature with saw dust mulch which improved the water content and minimized the water stress conditions. Further, the highest plant height was observed in stressful temperature with saw dust mulch which encourages good vegetative growth. Number of flowers of Red Okra (10) was highest in saw dust and straw mulch at temperature stress conditions but Green Okra (Haritha) produced only 8 flowers at the same experimental conditions without mulch treatment (Gunawardana *et al.,* 2011). Further, under ambient temperature, Red Okra pods

could be harvested 7 to 9 day after full blooming. Whereas, when there is temperature stress such as 34 ^{0}C, Red Okra pods could be harvested on 5 to 6 days after full bloom the pods were about 20 cm length which have a good market value. This study has showed even the Red Okra plants are exposed to temperature stress, pods harvested earlier than normal has the yield 37% higher than the pods grown under ambient temperature. Whereas in Green Okra (varity Haritha) pods have to be harvested 5-6 days when exposed to high temperature and the pod length was just 7-8 cm (Gunawardana *et al.,* 2011). Usually the small size Okra pods are not preferred by consumers as the edible part is less.

As global warming may not be controlled, careful planning of Red Okra cultivation with straw mulch will increase the yield even when there is temperature stress to plants growth. This may be due to the fact that vigorous growth and development of Red Okra in the higher temperature conditions lead to this production. This study shows that Red Okra could be a good adaptation measure for dry zone farmers when the temperature stress is a limiting factor for higher productivity by reducing the high air temperature effect on soils by using straw mulch. Straw is freely available in the dry zone and it could be a viable adaptation measure for farmers.

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Effects of Surface Modification of n-Cu_2O/p-Cu_xS Thin Film Heterostructures for Enhanced Liquefied Petroleum Gas Sensing Properties

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Abstract

We report a novel mechanism to effectively detect LP gas based on surface modification through sulphidation followed by passivation of electrodeposited *n*-type cuprous oxide (Cu_2O), forming a thin film *n*-Cu_2O/p-Cu_xS semiconducting heterostructure. Electrochemically deposited *n*-type cuprous oxide (n-Cu_2O) thin films on Ti substrates in acetate bath were sulphided using Na_2S to fabricate n-Cu_2O/p-Cu_xS heterostructures. Subsequent passivation of these thin film structures using $(NH_4)_2S$ vapor enhanced the sensitivity (fractional change in thin film resistance) when exposed to liquefied petroleum (LP) gas.

Scanning electron micrographs (SEM) confirmed that typical unsulphided n-type Cu_2O thin films exhibit polycrystalline surface morphology, while SEM of both sulphided and passivated thin films revealed micro/nano-crystalline surface morphological features with porous structures. As expected, the thin film structures obtained through sulphidation followed by passivation of n-type Cu_2O films decreased the resistance (~100 kΩ) in comparison to the resistance (~1 MΩ) of the unsulphided n-type Cu_2O thin films. Upon exposure to LP gas, the resistance of these thin film structures increased while, sensitivity to LP gas depended on the sensing temperature. Exposure of thin film structures fabricated by electrodepositing *n*-

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type Cu_2O thin films for 45 min, sulphided and passivated for 5 s and maintained at a sensing temperature of 45 °C to LP gas with a flow rate of 2.5 ml/min recorded the highest sensitivity of 48 %.

Keywords: Cuprous oxide, Sulphidation, Surface passivation, Gas sensor, Liquefied Petroleum gas, electrochemical deposition

Introduction

Liquefied Petroleum (LP) gas is used worldwide for domestic, commercial and industrial purposes and is a highly flammable gas. Therefore, availability of efficient and low cost LP gas sensors are of importance with regards to ensuring user safety. Gas sensing properties of metal oxide semiconductor such as SnO_2, CdO, ZnO, In_2O_3, TiO_2 (Huang & Wan, 2009; Eranna, *et al.*, 2004; Yamazoe, *et al.*, 2003) have been extensively studied while many semiconducting materials have been considered for LP gas sensing applications (Yadav, *et al.*, 2013; Gunjakar, *et al.*, n.d.; Dhawale, *et al.*, 2008; Bulakhe & Lokhande, 2014; Shukla, 2012; Shinde, *et al.*, 2007; Bandara, *et al.,* 2014). There are many parameters of materials that are important for gas sensing applications, for example, adsorption ability, catalytic activity, sensitivity and thermodynamic stability are some of them. Many different metal oxide materials are favorable in some of these properties (Bochenkov & Sergeev, 2010; Korotcenkov, 2007; Wang, *et al.*, 2010; Shishiyanu, *et al.*, 2006). Due to this situation, more recent works focus on composite materials, such as, ZnO-CuO, SnO_2-ZnO andα-Fe_2O_3/ZnO (Yoon, *et al.,* 1998; De Lacy Costello, *et al.*, 1999; Chen, *et al.*, 2008). Not only the binary metal oxides, there are also numerous ternary, quaternary and complex metal oxides, which are of interest for gas sensing applications (Zhang, *et al.*, 2006; Meng, *et al.,* 2013; Meixner & Lampe, 1996). It is also important to note that the detection of simple gases, through semiconducting metal oxides often require elevated temperatures (Arafat, 2012; Gopel & Schierbaum, 1995; Sun, *et al.*, 2012; Bochenkov & Sergeev, 2010).

Electrochemical deposition of Cu_2O films has attracted increasing interest due to its associated low temperature assisted, relatively

simple and low cost technique (Siripala, *et al.*, 2009; Rahman, *et al.*, 2015). Also, it has the ability to control the crystal growth parameters, morphologies, compositions through a systematic variation of electrode potential/current, electrolyte concentration, bath pH and deposition time *etc.* (Schlesinger, *et al.,* 2010; Bijani, 2009; Jayathilaka, *et al.*, 2012; Jayathilaka, *et al.,* 2014; Jayathilaka, *et al.*, 2014; Teterycz, 2001; Siripala & Kumara, 1989). However, comparatively limited work has been done on Cu_2O and its ability to detect LP gas (Gunjakar, *et al.,* n.d.; Bulakhe & Lokhande, 2014; Shukla, 2012; Shinde, *et al.*, 2007; Janantha, *et al.*, 2009).

Recent work on Cu_2O thin films un-doped and doped with chlorine have shown their ability to be sensitive to LP gas at relatively lower operational temperatures of ~85 °C and 50 °C respectively (Bandara, *et al.,* 2014).

Furthermore, gas sensors based on the two components mixed together are more sensitive than the individual components alone (Yoon, *et al.*, 1998; De Lacy Costello, *et al.*, 1999; Chen, *et al.*, 2008).

Formation of n-Cu_2O/p-Cu_xS heterostructures through sulphidation of electrodeposited *n*-type Cu_2O using 0.01M Na_2S at 200 °C was previously demonstrated by Jayathilaka *et al.* (Jayathilaka, *et al.*, 2012). In subsequent work, they showed that, the sulphur passivation of p-type Cu_2O (Jayathilaka, *et al.*, 2014) and n-type Cu_2O (Jayathilaka, *et al.*, 2014) thin film defects, using 50 vol. % $(NH_4)_2S$ vapor improves the electrical transport properties and photo-response characteristics of these thin films. The work has also shown that the resistivity of the passivated films decreased while preserving the structural integrity of the thin films. Previous work on the fabrication of copper sulphide thin films showing gas sensing properties using solution growth technique has demonstrated its ability to detect ammonia gas at room temperature (Sagade & Sharma, 2008). But it has not been tested for detecting LP gas. Here we report a novel mechanism to effectively detect LP gas based on surface modification through sulphidation followed by passivation of electrodeposited n-type cuprous oxide (Cu_2O), forming a thin film n-Cu_2O/p-Cu_xS semiconducting heterostructure.

Materials and Methods

Electrochemical Deposition of Thin Films

Initially n-type Cu_2O thin films were deposited on Ti substrates. Before deposition, the substrates were cleaned with detergent, dilute nitric acid, HNO_3 acetone and finally rinsed with distilled water. The Cu_2O thin films were potentiostatically electro-deposited in a three-electrode electrochemical cell that contained aqueous solutions of 0.1 M sodium acetate (98%) and 0.01 M cupric acetate (98 %) (Acetate bath). Deposition was carried out for different durations as required at 60 °C under a potentiostatic condition of -200 mV. The n-type conductivity of the deposited films was verified using spectral response measurements. Prior to sulphidation, deposited thin films were thoroughly dried. Then the Cu_2O thin films were sulphided by placing a drop and spreading into a thin layer of 0.01 M Na_2S using a liquid droplet marker and drying at 200 °C.

Films were thoroughly cleaned with distilled water and allowed to dry before any measurements. Followed by sulphidation, the surface passivation was achieved by exposing the films to 50 vol. % $(NH_4)_2S$ vapor at 27 ºC for about 5 s.

Characterization of Thin Films

The surface morphological and structural characterization of the films was determined using SEM (Philips XL40) and XRD (SHIMADZU SSX -550) analysis.

Gas Sensing Measurements

In order to test the gas sensing properties when exposed to LP gas, the fabricated sensors were housed inside a gas sensing chamber made of stainless steel (Figure 1). The chamber contained two compartments; the top through which the gas was flown and the bottom where the heating element was housed. Electrical resistance was measured between the contacts probes placed on the surface of the film. The probes were externally connected to a multimeter that was connected to a computer data logger. The sensor surface temperature was controlled by using a thermostat with a

temperature controller. Thin films were placed approximately 2 cm away from the gas inlet. Inset above shows a detailed geometry of the thin film structures used for sensing LP gas with gold spring probes placed on the top surface.

All the measurements were made under atmospheric conditions (ambient) by using a flow through technique. The LP gas flow rate was maintained at a constant rate of 2.5 ml/min, till the film resistance reached steady state. Thereafter, the gas flow was stopped and allowed to recover till it reached the ambient resistance. The sensing temperature was varied between 30 °C and 150 °C, monitoring through a thermocouple (type K) which was in contact with the surface of the thin film. The electrical resistivity measurements were made using computer interfaced Keithley 2100 digital multimeter. Typically, the steady state maximum was reached within 50 s after the films were exposed to LP gas. The process was repeated several times (up to 4-5 times) for a given sensing temperature. Measurements were repeated at different sensing temperatures ranging from 30 °C to 150 °C.

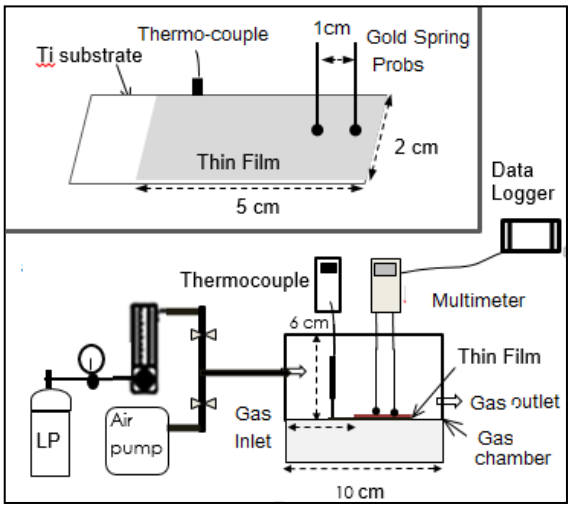

Figure1. Experimental setup used for testing thin film structures for its sensitivity to LP gas

Results

Structure and Morphology of Thin Films

Figure 2(a) shows the SEM view of a bare n-type Cu_2O thin film where there is a uniform coverage of polycrystalline grains. Figure 2(b) shows an SEM image of a sulphided and passivated thin film, confirming the porous micro/nanocrystalline surface morphological features.

Figure 2(c) indicates the XRD peaks of (i) untreated and (ii) sulphided and passivated n-type Cu_2O thin films. All the XRD peaks are due to Cu_2O and the Ti substrate. The sulphided and passivated n-type Cu_2O thin films do not show any Cu_xS peaks, presumably due to the extreme thinness of Cu_xS on the surface of the film. The formation of Cu_xS on the film surface has been verified by Jayathilaka *et al.* using X-ray photoelectron spectroscopy (XPS) measurements.

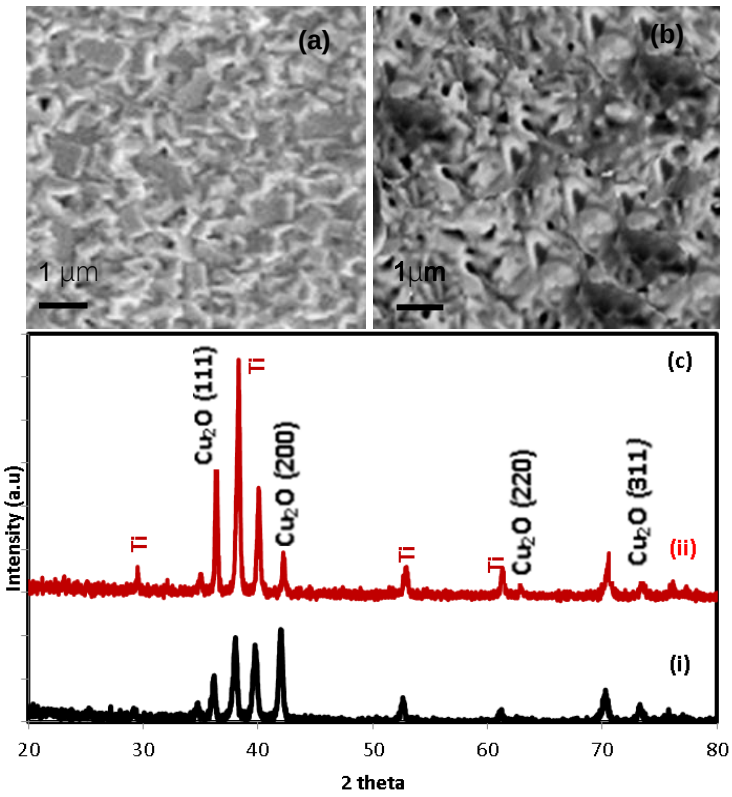

Figure 2. SEM picture of Cu_2O thin films
(a) n-type thin films fabricated in acetate bath
(b) sulphided and passivated (by placing a thin layer of 0.01M Na_2S at 200 °C and followed by exposure to 50 vol.% $(NH_4)_2S$ vapor for 5 s at 27 °C and
(c) XRD spectra for n-type Cu_2O thin film structures, (i) unsulphided (ii) sulphided and passivated by exposing to 50 vol.% $(NH_4)_2S$ vapor for 5 s at 27 °C.

Sensitivity of Thin Films to Liquefied Petroleum Gas

Untreated Cu_2O thin films showed a resistance ~1 MΩ which reduced down to ~ 100 kΩ after sulphidation and passivation. The sensor sensitivity (S) was calculated according to the following equation using the measured resistances.

$$S = \left|\frac{R_{LPG} - R_{Air}}{R_{Air}}\right| \times 100 \qquad (1)$$

where, R_{LPG} is the resistance of the film upon exposure to LP gas and R_{Air} is the resistance of the film under ambient atmospheric conditions.

Fabricated thin films were placed inside the gas chamber and resistance (hence the sensitivity) measurements were taken as a function of both time and sensor surface temperature. Upon exposure to LP gas, the resistance of the sulphided and passivated n-type Cu_2O films increased the film resistance. It gradually recovered to its initial ambient value when the LP gas flow was stopped**.** Figure 3(a) and Figure 3(b) show the resistance and the magnitude of sensitivity variations at sensor operating temperature at 45 °C obtained for sulphided and passivated n-type Cu_2O thin films upon repeated cycles of LP gas exposures. Response and recovery time of one cycle was completed around 100 s duration while, the sensor response was reproducible over all the LP gas exposure cycles. A steady state maximum sensitivity of 48 % was achieved when the sensor surface temperature was maintained at 45 °C, the optimum sensor operating temperature (see Figure 3c). Observations confirmed that the sensing temperature was a major

factor affecting the measured sensitivity. These films show greater sensitivity (~48 %) compared to unsulphided (~4 %) Cu_2O thin films (Bandara, *et al.*, 2014).

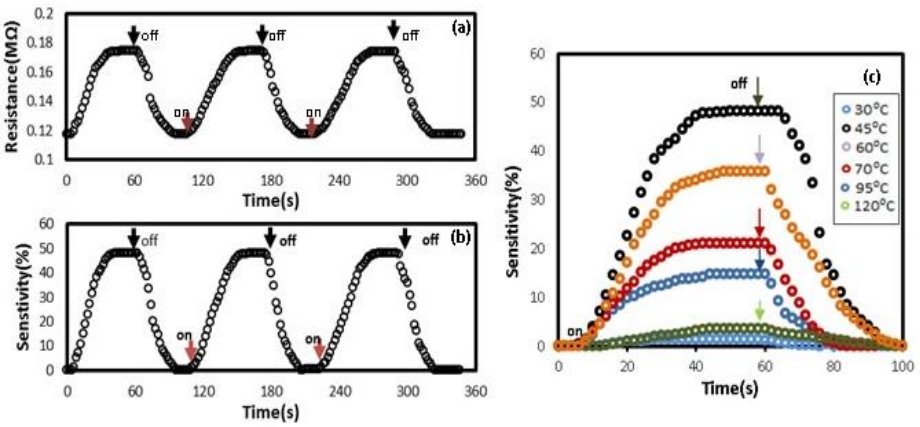

Figure 3: (a) Resistance and

(b) Sensitivity for a sulphided and passivated (by placing a thin layer of 0.01 M Na_2S at 200 °C and followed by exposure to 50 vol.% $(NH_4)_2S$ vapor for 5 s at 27 °C) *n*-type Cu_2O thin film structure operated at 45 °C. A gas flow rate of 2.5 ml/min was maintained during the ON cycle of gas flow to the thin film structure.

(c) Sensitivity measurements as a function of sensing temperature for the thin film structure used in (a), the arrows indicate the time at which the gas supply was turned OFF.

The LP gas reaction mechanism of the thin films showing LP gas sensing properties can be summarized as follows. The top surface of the thin films showing LP gas sensing properties gets exposed to ambient atmospheric oxygen. The top surface being p-type Cu_xS, chemisorbs oxygen to the surface, extracting electrons from the thin

film to form O_2^-on the film surface. This charge transfer process will increase the concentration of holes in the p-type Cu_xS, and thus will reduce the depletion region of the n-Cu_2O/p-Cu_xS heterostructure under ambient conditions. However, once exposed to LP gas, a reaction takes place that will remove the chemisorbed oxygen from the surface, giving the electrons back to the p-type Cu_xS region. The associated chemical reaction is given by the following equation (Shukla, 2012).

$$2C_nH_{2n+2}(ad) + O_2^- (ad) \rightarrow 2C_nH_{2n+1}\text{-}O + H_2O + 2e^- \qquad (2)$$

The newly released electrons will now go on to recombine with the majority carrier holes in the p-type Cu_xS region, which makes the film resistance increase, which was consistent with our observations. The decrease in holes in the p-type Cu_xS region will also allow the depletion region of the n-Cu_2O/p-Cu_xS heterostructure to increase. Therefore, the n-Cu_2O/p-Cu_xS heterostructure regulates the charge transfer processes discussed above. When the LP gas supply is stopped, chemisorbed LP gas molecules will gradually release from the surface and atmospheric oxygen will chemisorb back on the thin film, allowing the resistance to recover back to its ambient value and in the depletion region of the n-Cu_2O/p-Cu_xS heterostructure to recover back to its ambient condition.

Conclusions

In summary, a n-Cu_2O/p-Cu_xS heterostructure was realized by electrochemically depositing a n-type Cu_2O thin film on a Ti substrate, followed by sulphidation using Na_2S and passivation by $(NH_4)_2S$ vapor and was successfully used for the detection of LP gas. It can be clearly seen that the sulphidation with passivation has altered the gas sensing behavior of n-type Cu_2O thin films significantly. When exposed to LP gas, a maximum sensitivity (fractional change of resistance) as much as 48% at a relatively low sensing temperature of 45 ºC was recorded. Thus, the sulphidation has caused LP gas molecules to interact with the film surface more actively with a 10-fold increase compared to the maximum sensitivity of untreated Cu_2O films at 85 °C.

Acknowledgement

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Impact of Inlet Drying Temperature in Endless Chain Pressure Dryers on the Quality Characteristics of Leafy Type of Tea Produced Using Different Leaf Standards

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Abstract

This study was carried out to investigate the appropriate higher inlet drying temperatures in Endless Chain Pressure (ECP) dryers to assess the improvement of quality characteristic of Orthodox type of tea of seven grades (OP, OP1, PEKOE, FBOPF, FBOP, FBOPF1 and OPA) produced using three different standards of leaves. Selected Leaf standards were 40%, 50%, and 60% of good leaves (fine plucking of two leaves and a bud). Two different drying temperatures, 205 ^{o}F as the control and 230 ^{o}F as the treatment, selected for this study. Pilot scale Orthodox rollers with a capacity of 15 kg withered leaves were used to undertake Pure Orthodox manufacturing process. Experiment was conducted in triplicate for each leaf standard at two different drying temperatures. Dried tea samples were separated into seven grades namely OP, OP1, PEKOE, FBOPF, FBOP, FBOPF1 and OPA. Graded tea samples were organoleptically assessed for their liquoring properties such as infused leaf color, liquor color and strength, quality and the appearance of graded tea by professional tea tasters' in Colombo. Results revealed that there was no significant difference in liquoring properties of made tea produced at higher drying inlet temperature against dryer temperature of 205 ^{o}F for three different standards of leaf. It indicates that higher inlet drying temperature does not influence the overall quality of the liquor. However, a trend was observed that tea produced with 60% good leaves, gave better

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liquoring properties at 205 °F than the higher inlet temperature. Therefore, when there is 60% good leaves, maintaining higher inlet temperature for drying has not gained any advantage to produce tea with better liquor quality. The appearance of OPA, PEKOE, FBOP and FBOPF grades showed a significant difference when there is only 40% good leaves at higher inlet temperature of 230 °F. The appearance of OP, OP1 and FBOPF1 grades did not show a significant difference at higher inlet temperature for all three leaf standards of 40%, 50% and 60% good leaves. Therefore, better appearance can be achieved by maintaining higher inlet temperature of 230°F when there is only 40% good leaves.

Keywords: Endless Chain Pressure dryer, infused leaf, Leaf standard, liquor color and strength, pilot scale manufacture.

Introduction

Tea estates are ranked according to the net sale monthly average price and to date average price. Some estates in the same region are at the top of the ranking while others are in the middle or at the bottom due to the price variation of their net sale average (NSA). One reason for the demand for their tea grades may be good manufacturing practices in addition to maintaining better leaf standards. Leaf standards mean the percentage of good leaves (fine plucking). The leaf standard varies from estate to estate based on the harvesting policy adopted. Green leaf is the raw material for black tea processing and it is important to have a good quality black tea. Good leaf is named as "Tender leaf" that consists of two leaves and the bud (Fine plucking) (Tubb, 1999). Hundred percent good leaves are not practicable. Therefore, Tea Research Institute (TRI) recommends 60-65% of good leaves (on count basis) to ensure better quality of the end product (Robert, 2008). Also product consistency has a significant impact on achieving better colour and taste (Samaraweera and Ziyad, 2008). In tea drying inlet temperature of 190-200 °F and exhaust temperature of 120-130 °F represent the normal range of temperature used in Endless Chain Pressure (ECP) dryer (Jayaratnam and Kirthisinghe, 1974). Most of the low country tea producers increase the drying temperature higher than the

recommended level (190 °F) with a view to improve the appearance/ blackness. However, they do not have a clear idea about the potential impact on liquoring properties of made tea while increasing inlet temperature higher than the recommended level. In this study, an attempt was made to find out whether there is a correlation between the leaf standards (40%, 50% and 60% good leaves) and inlet drying temperature levels for seven tea grades. Further, attempt was also made to determine/compare final made tea quality at both higher inlet temperatures and at recommended drying temperature levels. Objective of this experiment was to study the impact of different inlet temperatures of the ECP dryer on the quality of made tea of seven grades produced from different leaf standards and to assess the liquoring properties and appearance of leafy type of graded tea Organoleptically.

Methodology

The experiment was conducted at Processing and Technology Division, Tea Research Institute of Sri Lanka at St. Coombs Estate, Talawakelle. The Agro ecological zone of the area is WU3. Tea leaves used for this experiment were collected from factory withering troughs, which were dominated by shoots of TRI 2025 cultivar. Leaf standard of normal estate plucking policy varies from day to day. Three different leaf standards were selected for this study which was 40%, 50% and 60% good leaves (fine plucking). Fine plucking means two leaves and a bud which gives rise to bright red liquor both in plain and milky teas (Naheed *et al*, 2007). Before the leaves were collected for the experiment, and leaf standard was calculated by picking leaf samples randomly from the trough and determining the good leaf percentage. If the percentage of the leaves was similar to the experimental standard, trough was selected for the experiment. In this study, 230 ^{o}F inlet drying air temperature was selected as the treatment while 205 ^{o}F as the control for ECP dryer. The reason for selecting 230 ^{o}F was that most of the low country tea producers are using this temperature. Six treatment combinations are shown in the Table. 1.

Table 1. Treatment plan of the experiment

	Leaf standard-Good leaves (%)		
Inlet Temperature	40 (L1)	50 (L2)	60 (L3)
205°F (T1)	L1T1	L2T1	L3T1
230°F (T2)	L1T2	L2T2	L3T2

Types of Plucking

Usually shoots with two leaves and the bud are fine plucking. Tea shoots with more than two leaves during the low cropping season is considered as coarse plucking. However, shoots with three leaves and a bud are also accepted as fine plucking during the high cropping season due to the tenderness of the third leaf (Botheju, 2001). The factory trough consisted of a mixture of shoots; bud and two leaves, bud and three leaves, soft banji bud (undeveloped) with two tender leaves, (described as fine leaf plucking) mother leaves/coarse leaves and damaged leaves, which are considered as fish leaf plucking or hard plucking (Figure 1).

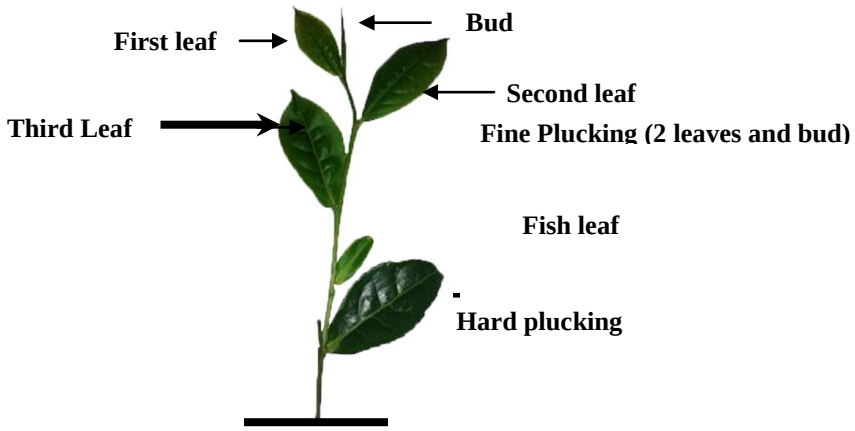

Figure 1. Tea leaves (Tender leaves and coarse leaves)

Experimental Design

Experiment was carried out as a 2 factor factorial design (*i.e.* three different leaf standards (40%, 50% and 60% good leaves of fine plucking) and two drying inlet temperatures (205 °F and 230 °F) with

three replicates per each treatment combinations.

Procedure in Made Tea

Plucked leaves were withered on factory withering troughs for 12-16 hours until its moisture was reduced to 55-57% (Roberts, 2008). Withered leaf samples (50 g) drawn from withering trough in duplicate were used to test moisture content. After completion of the withering process, withered leaves were processed separately for treatment samples and control samples using set of medium sized pilot scale manufacturing machines available at St. Coombs factory. In the process of manufacturing, weighed (15 kg) withered leaves were rolled using single action pilot scale Orthodox roller. After rolling for 30 min period, rolled leaves were discharged and separated to even size particles (dhool) using pilot scale oscillatory type roll breaker. No 4 mesh fixed to roll breaker was used to separate tea dhool. The rolling operation was continued until big bulk percentage reached to about 32%. Each dhool (1st and 2nd dhool) from the treatment and control samples were mixed and spread on clean fermenting trays separately for about 5 cm height to facilitate fermentation. The humidity level of the fermenting area was maintained using humidifiers in order to keep hygrometric difference below 3 ^{o}F (Samaraweera, 1986). After about a 3 hour fermentation period, fermented dhools were subjected for drying using ECP dryer.

Hot air required for drying was generated using electrical heating element that has five different power ratings. In this study, drying inlet temperature of air selected for treatment sample was 230 ^{o}F whilst for the control sample it was 205 ^{o}F. Exhaust air temperature of the dryer outlet was maintained at 135 ^{o}F. The residence time was approximately 21 min. Dried tea from treatment and control samples were graded using hand sieves. The sieve sizes such as No.4, No.5, No.8, No.10, No.12, and No.16 were used to obtain seven different grades; OPA, OP, OP1, PEKOE, FBOP, FBOPF1 and FBOPF (Figure

Figure 2. Different grades of Tea

Tea Tasting

Graded tea samples were sent for tea tasters' evaluation in Colombo and assessed for organoleptic qualities or liquoring properties based on the characters such as infused leaf color, tea liquor color, strength, quality and flavor. Liquoring properties and appearance of 126 tea samples produced were evaluated by specialized tea tasters.

Liquoring Properties

Sensory evaluation of tea quality depends on visual observation, smelling and tasting senses by tea evaluation specialists to determine the tea quality. In this method the taster judges the quality parameters by assessing the physical attributes of liquor and infused leaf of the tea. Based on the tasters' evaluation marks, Overall Quality was calculated by using different liquoring properties such as infused leaf colour, liquor colour and strength, quality and flavor for three different leaf standards (40%, 50% and 60% good leaves) of individual grades.

- **Infused Leaf**

Analyzing the infused leaf allows the taster to set certain impressions of the tea before tasting. The most important part of a taster's palate is a sense of smell. Infused leaf can inform smells indicating problems in production, storage or the presence of certain regional characteristics. Bright appearance indicates bright liquors. Lack of brightness usually denotes poor tea.

- **Colour**

Liquor colour is one of the most important quality parameters of tea. Liquor colour is considered the qualifying factor for quality. The variation of liquor colour from greenish to yellow to deep brown or blackish brown is mainly due to the extent of thevafalvins (TF) and thearubigins (TR) formation during manufacturing of the tea. The perfect colour of infused leaf is bright copper or red (Biswas, 2014).

- **Strength**

This denotes substance in liquor and is generally described by a qualifying adjective such as “strong”, “very strong“ or ”fair strength”. Liquor colour is a good guide to strength; pale and light looking tea liquors generally have less strength than coloury liquors. Within grades from the same estate, strength normally follows colour and the colouriest grades, usually Dusts are the strongest.

- **Quality**

This is the essential characteristic of a good tea and is an impression derived from the palate when tea liquor is tasted. Although it is not possible to explain what quality in tea actually tastes like, it is possible to say that common, coarse and plain liquors are severely lacking in this quality.

- **Flavor**

Flavor is a most noticeable aroma, which is sensed through the mouth as different from the nose. The most delicate flavors are found on estates at high elevations. Sri Lankan teas from high elevations are popular for their fine flavor liquors, with seemingly limitless flavors. Researchers have identified five flavors that cause taste sensation (sweet, bitter, sour, salty, and savory). But tasting is actually much more complex.

- **Overall quality**

The term 'overall quality' is used as a description of all the characters of tea by which it is judged on its market value. Overall quality means the summation of the desirable attributes of the characters like infused leaf, colour, strength, quality and flavor in this experiment.

Results and Discussion

Liquoring Properties

No significant difference was observed for overall quality of OP graded tea samples produced by treatment at 230 °F inlet temperature and control at 205 °F inlet temperature for three different leaf standards of 40%, 50% and 60% good leaves (Figure 3). However, in OP grade of 60% good leaves, there was an increase in overall quality at 205 °F compared with 230°F. Therefore, it is indicated that there was an advantage of using drying inlet temperature at 205 °F to produce tea with better liquoring properties when there is 60% good leaves. However, when there is only 40% good leaves, inlet temperature at 230 °F may increase the overall quality.

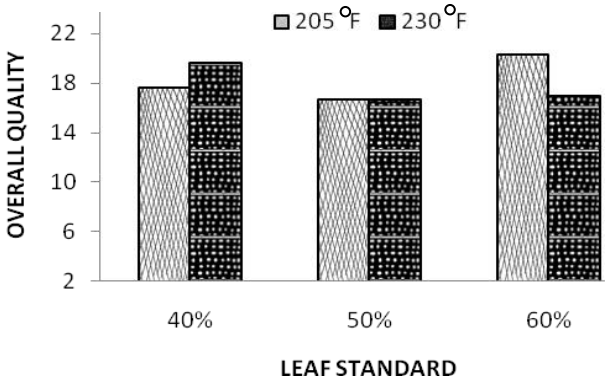

Figure 3. Overall qualities of OP grades at 205 °F and 230 °F for three different leaf standards

With respect to OP1 grade of 60% good leaves there was an increase in overall quality at 205 °F compared with 230 °F (Figure 4). Therefore, it is indicated that there was an advantage of using drying inlet temperature at 205 °F to produce tea with better liquoring properties when there is 60% good leaves.

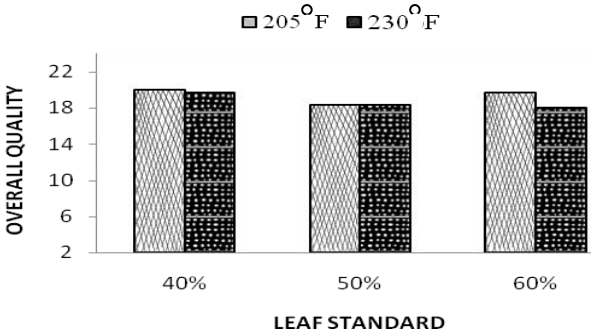

Figure 4. Overall qualities of OP1 grades at 205 °F and 230 °F for three different leaf standards

No significant difference was observed for overall quality of PEKOE graded tea samples produced by treatment at 230 °F inlet temperature and control at 205 °F inlet temperature for three different leaf standards (Figure 5). However, in PEKOE grade of 60% good leaves, there was an increase in overall quality at 205 °F compared with 230 °F. Therefore, it indicated that there was an advantage of using drying inlet temperature at 205 °F to produce PEKOE grade tea with better liquoring properties when there is 60% good leaves.

No significant difference was observed for overall quality of OPA graded tea samples produced by treatment at 230 °F inlet temperature and control at 205 °F inlet temperature for three different leaf standards (Figure 6). However, in OPA grade of 60% good leaves, there was an increase in overall quality at 205 °F compared with 230 °F. Further, when there are 50% good leaves, also there is also an increase in overall quality at 230 °F drying inlet temperature.

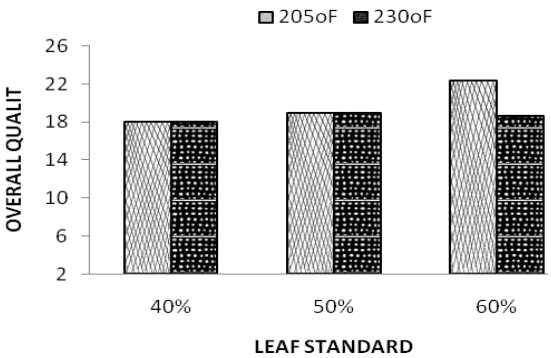

Figure 5. Overall qualities of PEKOE grades at 205 °F and 230 °F for three different leaf standards

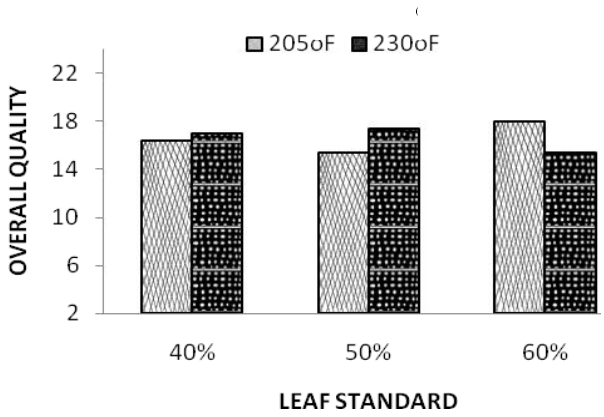

Figure 6. Overall qualities of OPA grades at 205 °F and 230 °F for three different leaf standards.

No significant difference was observed for overall quality of FBOP graded tea samples produced by treatment at 230 °F inlet temperature and control at 205 °F inlet temperature for all three different leaf standards (Figure 7). However, in FBOP grade of 60% good leaves, there was an increase in overall quality at 205 °F compared with 230 °F. Whereas, when there is 40% good leaves, overall quality may increase at drying inlet temperature of 230 °F.

Results revealed that no significant difference was observed for overall quality of FBOPF1 graded tea samples produced by treatment

at 230 °F inlet temperature and control at 205 °F inlet temperature for three different leaf standards (Figure 8). However, in FBOPF1 grade, there was an increase in overall quality at 205 °F compared with 230 °F for all three percentages (60%, 50% and 40%) of good leaves.

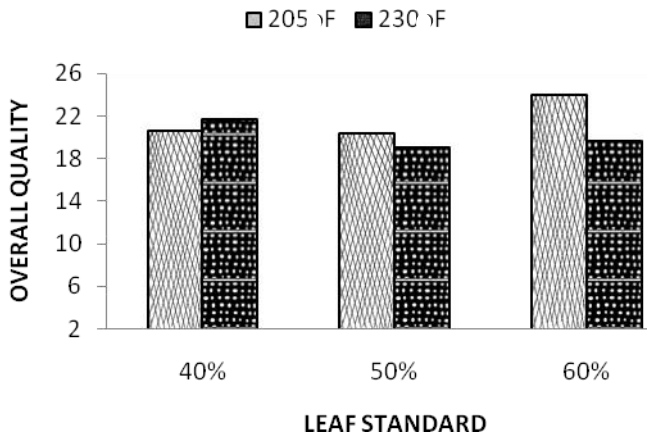

Figure 7. Overall qualities of FBOP grades at 205 °F and 230 °F for three different leaf standards

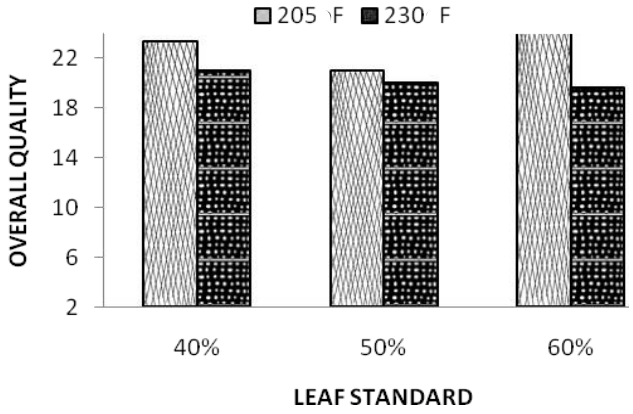

Figure 8. Overall qualities of FBOPF1 grades at 205 °F and 230 °F for three different leaf standards.

According to the analysis of variance procedure, no significant difference was observed for overall quality (at the alpha level of 0.05) of FBOPF graded tea samples produced by treatment at 230 °F inlet temperature and control at 205 °F inlet temperature for three different leaf standards (Figure 9). However, in FBOBF grade of 60% leaf standard, there was an increase in overall quality at 205 °F compared with 230 °F. Therefore, it indicated that there was an advantage of using drying inlet temperature at 205 °F to produce tea with better liquoring properties when the leaf standard is 60% good leaves.

When all seven grades *viz*. OP, OP1, PEKOE, OPA, FBOP, FBOPF1, and FBOPF were considered, it was clearly shown that there was an advantage of using inlet temperature for drying at 205 °F in ECP dryer when the leaf standard is 60% of good leaves in pure Orthodox manufacture to achieve good overall quality of liquoring properties even though the treatments are not significant (Table 2).

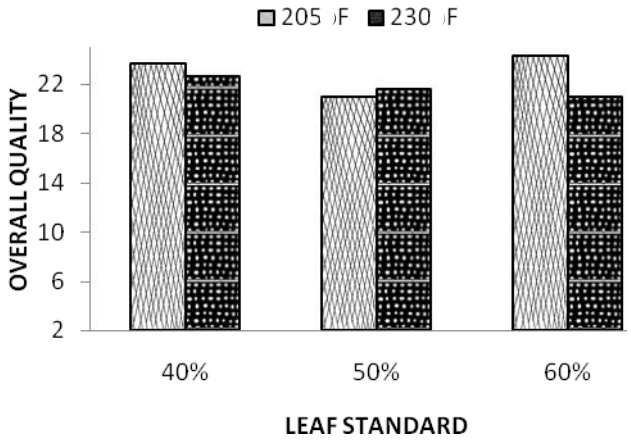

Figure 9. Overall qualities of FBOPF grades at 205 °F and 230 °F for three different leaf standards

Table 2. Mean values of overall qualities of seven different grades for treatment and control drying temperature for three different leaf standards (a) treatment combination, (b) Leaf Standard (%)

(a)	(b)	Temp (°F)	**Overall qualities of Grades**						
			OPA	**OP**	**OP1**	**PEKOE**	**FBOP**	**FBOPF 1**	**FBOPF**
L1T1	40	205	16.3[a]	17.6[a]	20[a]	18[a]	20.7[a]	23.3[a]	23.7[a]
L1T2		230	17[a]	19.7[a]	19.6[a]	18[a]	21.6[a]	21[a]	22.7[a]
L2T1	50	205	15.3[a]	16.6[a]	18.3[a]	19[a]	20.3[a]	21[a]	21[a]
L2T2		230	17.3[a]	16.7[a]	18.3[a]	19[a]	19[a]	20[a]	21.7[a]
L3T1	60	205	18[a]	20.3[a]	19.7[a]	22.3[a]	24[a]	25.3[a]	24.3[a]
L3T2		230	15.3[a]	17[a]	18[a]	18.7[a]	19.7[a]	19.7[a]	21[a]

Means with the same letter are not significantly different.

This is because the production of quality black tea depends on the concentration of chemical compounds in young and tender leaves. The chemical constituents of leaf are located in compartments or cells within the leaf. Also, leaf contains a group of proteins called enzymes. The enzymes are responsible for controlling all processes within the cell. One important enzyme for tea manufacture is the polyphenol oxidase which has the ability of reacting with the polyphenols present in leaf. The coarse leaves and stems have a low concentration of enzymes and chemical constituents compared to the tender leaves (Robert, 2008).

The quality of made tea depends on the presence of desirable compounds, undesirable compounds, and the feeling and sensitiveness of taste. The tea tasters evaluate the quality by a different number of parameters and they use different terms to express the quality (Wickramasinghe, 1978). However, biochemical ratio between thearubigin (TR) and theafavin (TF) is used to evaluate the quality of tea. The quality is mainly depends on two classes of substances called theafavin (TF) and thearubigin (TR). The taste is also associated with the oxidation process. The optimum fermentation condition is required for better taste by producing the correct combination of TR and TF. Under fermentation may

contribute to the bitterness of the cup of tea due to unoxidized poly phenols. Over fermentation may hide the strength of the made tea.

Appearance of made tea

The appearance of seven graded made tea samples from treatment and control temperatures and three different leaf standards of 40%, 50% and 60% of good leaves were evaluated by professional tasters by comparison. Samples were visually observed to determine the blackness from both higher inlet temperature and the control temperature.

Blackness of all graded tea samples manufactured from both 230 ^{o}F inlet temperature and 205 ^{o}F control temperature were analyzed by statistical analysis system ANOVA procedure followed by Duncan's Multiple Range Test ($p < 0.05$).

- ***Analysis for PEKOE, OPA, FBOP and FBOPF grades***

Figure 10 shows the blackness of PEKOE grade. According to the graph, more blackness was received for higher inlet drying temperature of 230 ^{o}F for 40% and 60% good leaves standards compared to control temperature**.** The blackness of PEKOE grade tea produced at different temperature showed significant difference according to the analysis of variance (ANOVA).

According to the analysis of variance (ANOVA) procedure, there was a significant difference (P value is smaller than 0.05 significance level < 0 .0001) among the mean blackness of OPA tea grade with respect to different inlet temperature combinations (Figure 11). More blacker in colour was received for 40% and 60% good leaves at higher inlet temperature (230 ^{o}F). It indicated that higher inlet temperature (230 ^{o}F) for 40% and 60% of good leaves produces a blacker appearance than control temperature (205^{o} F).

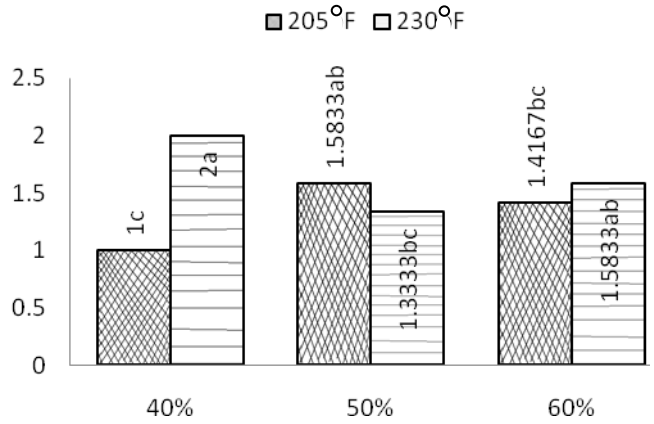

Figure 10. Overall blackness of PEKOE grades at 205 °F and 230 °F for three different leaf standards (Means with different letters represent significant different at 5% level)

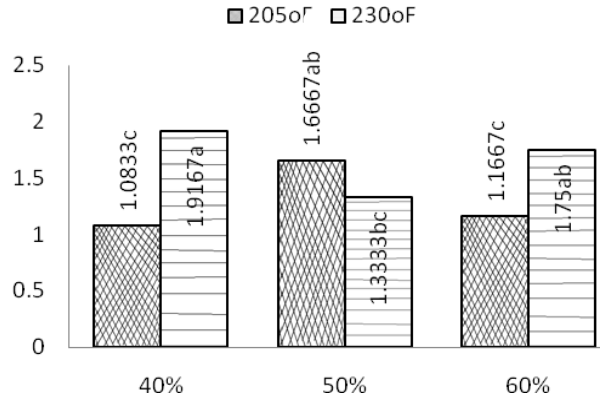

Figure 11. Overall blackness of OPA grades at 205 °F and 230 °F for three different leaf standards

The result indicated that there is a significant effect (p = 0.0001) on blackness of FBOP grade with treatment combinations according to the analysis of variance (ANOVA) procedure. Both 40% and 60% of good leaves resulted more blackness at the higher inlet drying temperature (230 °F) compared to control temperature (205 °F). Hence, there is no significant effect on 50% of good leaves from both temperature levels.

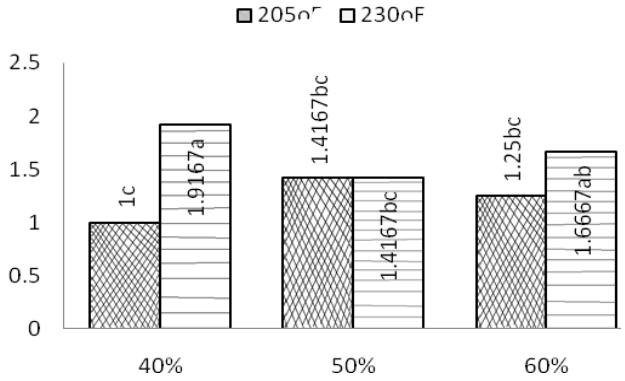

Figure 12. Overall blackness of FBOP grades at 205 °F and 230 °F for three different leaf standards

Blackness of FBOPF tea grade significantly varied (P = 0.0001) with the different treatment means according to the analysis of variance (ANOVA). More blackness was received at higher inlet drying temperature (230 °F) for 40% and 60% of good leaves (Figure 13). Therefore, higher inlet drying temperature for 40 % and 60% of good leaves of FBOPF tea grade gives a blacker colour compared to control temperature.

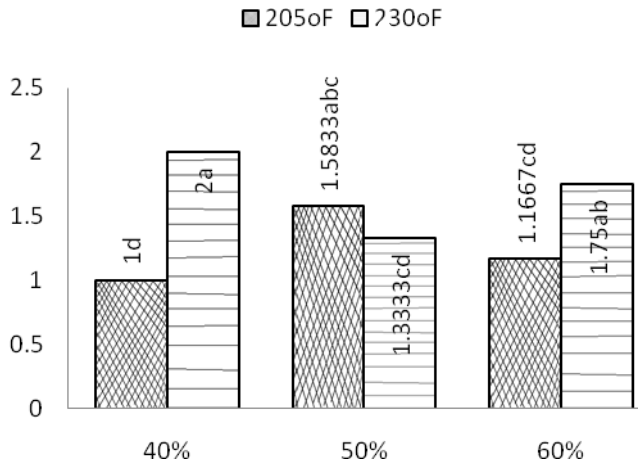

Figure 13. Overall blackness of FBOPF grades at 205 °F and 230 °F for three different leaf standards

The appearance of OPA, PEKOE, FBOP and FBOPF grades showed a significant difference in blackness when the leaf standard was 40% of good leaves at 230 °F inlet temperature (Figure 14).

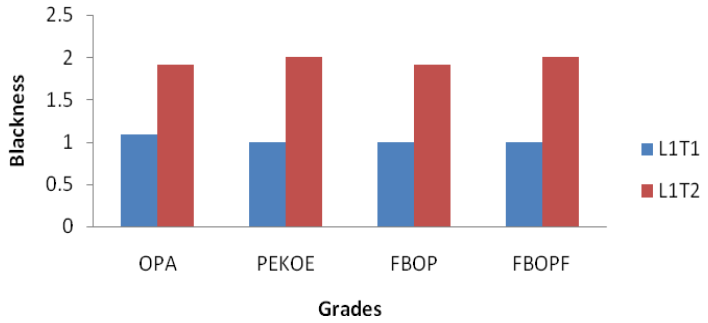

Figure 14. Overall appearances of OPA, PEKOE, FBOP, FBOPF grades at 40% of good leaves with 205 °F and 230 °F

- ***Analysis for OP, OP1 and FBOPF1 grades***

According to the analysis of variance (ANOVA) procedure, there was no significant difference of appearance observed for the grades of OP, OP1 and FBOPF1 for different leaf standards and higher inlet drying temperatures (at the alpha level of 0.05). Therefore, it indicates that there was no appearance difference observed at the control and higher inlet drying temperature for the different grades.

Conclusions and Recommendations

Results revealed that there was no significant difference in liquoring properties of made tea produced at higher drying inlet temperature (230 °F) when compared to 205 °F for the three different leaf standards of 40%, 50% and 60% of good leaves tested. Therefore, overall liquoring quality of made tea has no strong correlation between treatments according to the analysis. However, a trend was observed for tea produced using 60% good leaves (leaf standard) which gave better liquoring properties at 205°F than the higher inlet temperature (230 °F). Therefore, when the leaf standard is good (60% of good leaves), maintaining higher inlet temperature (230 °F) for

drying has not resulted in a specific advantage in relation to liquor quality. Therefore, it can be concluded that an effective way to reach the final quality of made tea by saving power and energy is to use the 205 ^{o}F inlet drying temperature in the ECP dryer.

However, when the leaf standard is low, only 40% of good leaves using higher inlet drying temperature (230 ^{o}F) will enhance the appearance or blackness in tea grades of OPA, PEKOE, FBOP and FBOPF. The appearance of OP, OP1 and FBOPF1 grades did not show a significant difference at higher inlet temperature in relation to all three leaf standards (40%, 50% and 60% of good leaves). Therefore, a better appearance can be achieved by maintaining higher inlet drying temperature for leaf standard for only 40% of good leaves.

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Human Smuggling–Implications on Rights of Migrants: An Examination from the Standpoint of International Law

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Abstract

Human smuggling is a transnationally planned, coordinated and executed crime that is more often perpetrated by organized criminal networks. It is not merely the smugglers who are in search of the lucrative business but also the smuggled migrants, who give the green light, collaborate and connive in the crime. The impulse to seek new economic opportunities and look for greener pastures, yearning for individual or familial betterment and in certain circumstances, making a getaway from conflict and persecution become the motivating factors for migrants to take the desperate step of consenting to be smuggled out of the country. The modus operandi is by Air, Sea and land where the lives of the smuggled migrants are put at risk during the journey.

Lives of the smuggled migrants are put at risk whatever may be the means of transport during the journey. Lacking legal status, migrants are vulnerable to human rights violations, especially of labour rights. They are subject to rigorous controls and even to sexual exploitation. Although migrants may act in collusion with the smugglers, it is increasingly recognized that they are victims of circumstances and stand in dire need of being protected by society.

This article seeks to inquire into and examine the rights of smuggled migrants as are recognized in the context of the provisions in international law. Special attention is given to United Nations Convention against Transnational Organized Crime 2000 (UNCTOC) and the Protocol Against the smuggling of Migrants by Land, Sea

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and Land Supplementing the United National Convention against Transnational Organized Crimes 2000 (Protocol). Besides a careful perusal of these documents, the article also appraises the provisions available under the other International Human Rights Instruments and Conventions relating to status of refugees 1951.

The first part of the article discusses the right to movement and international laws governing human smuggling. The second part identifies and explains the differences between human trafficking and human smuggling. The third part sheds light on the rights of smuggled migrants available under international law. This part focuses on UNCTOC protocol, CSR and other international human rights instruments (IHR Instruments). The last part of this article is a summary with the inclusion of some suggestions.

Keywords: Human Smuggling, Human Rights, Smuggled Migrants, International Law, Protocol Against the Smuggling of Migrants by Land, Sea and Land

Introduction

Migratory processes are set in motion by a variety of factors such as landlessness, flight from poverty with no economic prospects in view, natural disasters, internal conflicts and war. Mingled with dreams of freedom from want, the lure of wealth and escape from persecution have been the factors that have impelled people to move away from their homes and familiar surroundings (Migration Report, 2013).

Human migration is a delicate policy issue that has various ramifications having consequences for nearly all countries caught up and involved in the migration process in some way or other. As the process of migration continues unabated and as it involves the relationships of many countries, the need for an integrated and systematized action especially in respect of legislative measures has acquired an ever increasing importance.

Migration can be undertaken through legally accepted channels or it can be done illegally. Illegal movement across borders is being undertaken through trafficking and by smuggling. While the distinction between the two has been explained in detail in the second part of the paper, the main focus of the research is on human smuggling.

Human smuggling is characterized by collusion between the smugglers and those who are smuggled. It is an act of desperation in

an attempt to escape from poverty, fear of persecution, ethnic strife or civil unrest (Howie, 2013, Jayatilake, 2009). Besides the general factors there may be also country specific factors that set in motion human smuggling. E.g: Emly Howie (2013) in his study found that security threat and loss of confidence in reconciliation, and uncertainty about the future are some of the motivating factors in Sri Lanka. Unemployment is the main reason in China (Cleo, 2000) and in Nigeria (Salt, 2000) Receiving countries are also tempted by cheap availability of labour (Cleo, 1999-2000).

Stringent immigration policy and corrupted officials in the source country are also contributory factors for setting in motion the process of human smuggling. (Kevin Tissre, 2006)

Human smuggling incidents have been increasing throughout the world (World Migration Report 2013, Bali Process 2012). Most countries of origin are from Asia and Africa. Preferred destination countries are Australia, Canada, UK and the US (UNDOC, 2011).

Despite absence of proper data collection, an estimated 40,000 irregular migrants have died worldwide during the risky journey that is an integral part of the human smuggling process from 2000 to 2015 (UNODC, 2015).

The international measures to deal with human smuggling were adopted recently only about two decades ago (UNCTOC, 2000). There are two critical issues that are encountered in addressing human smuggling. They are (1) prevention of human smuggling as a criminal activity (2) Simultaneously protection for victims of human smuggling and ensuring their rights. (Article 2 and 5 of the Protocol)

In addition to UNCTOC and the Protocol, UN model Law against human smuggling and other IHR instruments will also be looked into to see the provisions governing human smuggling.

The first part of the article discusses the Right to movement in conjunction with international laws governing human smuggling. The second part identifies and explains the differences between human trafficking and human smuggling. The third part sheds light on the rights of smuggled migrants available under international law. This part focuses on UNCTOC, Protocol, CSR and other IHR Instruments. This article concludes with is a summary and suggestions.

In the first part, the author explains the right to movement as a general right. After giving an overview of the right to movement, the author sets out how the right to movement is being governed by immigration policies and procedures of States. Such policies and procedures create constraints to leave of country legally. The author explains human smuggling as one of the illegal modes of travelling to another country. Further, this part gives an overview of the International Legal Framework on human smuggling.

The second part focuses on the misconception of human smuggling and human trafficking being considered as one and the same offence. The author explains the differences between these two modes before discussing the rights of smuggled migrants. The misconception between trafficking and smuggling undermines the development of a separate domestic legal framework in certain countries, and is also an impediment for data collection. Data are scattered and difficult to gather. Moreover, any literature dealing with human smuggling invariably discusses the difference between human trafficking and human smuggling. Recognizing that there are similarities between these two techniques, there is a need for an unambiguous recognition that they are two distinct categories of crimes.

The third part is concerned with the international treaty provisions available to safeguard the rights of smuggled migrants.

The last part summarises the discussion and attempts to make suggestions to strengthen the available international legal framework to achieve the objective of protecting the rights of smuggled migrants.

Statement of the Problem

Human smuggling has expanded so fast that it has now acquired a global dimension and is posing a serious threat to many countries. There is evidence to show that human smuggling related offences have increased at the same pace as that of the increase in irregular migrants. A large number of victims of human smuggling are vulnerable to human rights abuses before, during, after departure and even after return. It seems that even though several international legal instruments have been adopted, the smuggled migrant's rights are not protected satisfactorily. Therefore, the researcher tries to analyze the provisions of international law governing rights of smuggled migrants to see to what extent the provisions are sufficient to cope with the situation.

Objectives

The main objective of this article is to identify and analyze the provisions recognizing rights of smuggled migrants and find any lacunae that may exist in international law and make suggestions to remedy them. The secondary objective of the paper is to enhance and reinforce knowledge on the rights of smuggled migrants under the provisions that are available in international human rights law.

Methodology

This is both a descriptive and an analytical study. The author describes the provisions available under international law and analyzes them. The justification for adopting this methodology is to achieve the main objective of the research paper of understanding as to what degree measures are available in international law and identify lacunae that may exist.

UNCTOC, Protocol, International Covenant on Civil and Political Rights (ICCPR) International Covenant on Economic, Social and Cultural rights, (ICESCR) Convention on the Rights of the Child, (CRC) Convention against Torture (CAT) have been used as primary data, and Journal articles, reports, guide books, web resources have been analyzed as secondary data.

Theoretical Framework

Global literature available on human smuggling brings the issue of human smuggling under different theoretical models (Theodre, 2013). Human Rights based Model is one of the theoretical approaches developed by scholars. Research studies based on Human rights based model analysis is about the role of the international, regional, and national actors criminalizing smuggling and protecting the rights of the smuggled migrants. According to Obakaoto (2005) this model theorizes that the states have obligations to ensure the rights of smuggled migrants irrespective of their status. Most of the literature is based on this focus on the obligations of the destination countries. According to UNCTOC and the Protocol, protecting rights of smuggled migrants are transnational duties. Andreas Schloenhardt, and Kate L Stacey suggests that any action with regard to human smugglers should take into consideration the human rights approach.

International law requires States to take legal, institutional and other measures to ensure rights of smuggled migrants. In the first instance, the Country of origin has a responsibility to address the root causes of human smuggling. The countries of destination as well as the transit countries also bear a responsibility to safeguard human rights

In the context of the human rights based model, the author looks as to what extent international law has incorporated provisions to protect the rights of smuggled migrants.

Results and Discussion

Part I –1.1 Right to Movement as a Human Right

One of the primary concerns of the United Nations Organization established at the end of World War II was to give priority to the rights of migratory settlers, as the war itself had generated displacements and migration on a massive scale. Universal Declaration of Human Rights (UDHR 1948) was the first document in which human rights were codified after the Second World War. Article 13 of the UDHR recognizes the right to movement and asylum. Even before adopting major binding international human rights instruments such as ICCPR and ICESCR in 1966, the CSR was adopted in 1951 to provide asylum based on five grounds enumerated under Article 2 (1) A of the convention. It was initially limited to protecting European refugees of Second World War from before 1 January 1951. Later, this Convention was supplemented by 1967 protocol to remove the time limit and cover all territories in the world (Paul Weis, 2001-2016). It is clear from the above measures that UN had given prior importance to rights of migrants.

Whether migrants or not, the UN deliberated on the essential rights that should be available to all human beings and after detailed discussions by representatives of all countries, the decisions were enshrined in what came to be known as the UDHR. Various international instruments of the UN were promulgated subsequent to this declaration. Since 1945, there have been several UN conventions declarations and protocols that have directly and indirectly dealt with issues concerning the rights of migrants.

Article 13 of the UDHR states "*Everyone has the right to freedom of movement and residence within the borders of each State. Everyone has the right to leave any country, including his own, and return to his country*. Similar provisions could be found in other IHR instruments

(ICCPR (Article 12), Convention on the Elimination of All forms of Racial Discrimination, (Article 5). The framework Convention for the Protection of National Minorities of Council of Europe has expressed provisions to recognize the right to movement.

In exercising this right, people have adopted different *modus operandi* to move from the country of origin to another both that come within the framework of legality and also through unlawful practices.

The international human rights law requires the states to protect the rights of everyone irrespective of their status. Nevertheless, it has to be observed that countries have discretion to regulate their migration policy. However, Human Rights Committee in its general comments 27 (CCPR/C/21/Rev.1/Add.9 (1999) states that the restrictions on the rights to movement should be provided by law. The committee emphasizes in the same comment that "*The restrictive measures must not "swallow the rule". "The application of restrictions in any individual case must be based on clear legal grounds and meet the test of necessity and the requirements of proportionality*".

Countries have put in place immigration laws and administrative guidelines to govern legal migration. Anyone wanting to migrate for legitimate reasons has to fulfill statutory and administrative requirements of host countries. Applicant has to satisfy the requirements of host countries. This may be perceived as insurmountable obstacles. Given such a situation, it is no surprise that many people wish to choose the services of the smugglers though expensive. Smugglers take the responsibility of organizing documents and passage to destinations.

If someone wishes to seek refugee status due to persecution as enumerated under the CSR 1951, he or she has to satisfy the requirements established under that convention. Article 2 (1(A) of the refugee CSR defines who is a refugee. The refugee status can be claimed based on ground of ethnicity, nationality, religion, political opinion and particular social group. Policies and laws have been developed to regulate all types' migration and refugee claims. Canada's Immigration and Refugee Protection Act 2001, Australian Migration Act 1958 with amendments and US Refugee Act of 1980 are some of the laws which grant visa or refugee status on conventional grounds. If they fail to prove the conditions laid down under these laws they will be sent back home.

1.2 International Law Governing Human Smuggling

According to Salt & stain (1997) the discussion on organized transnational crimes, trafficking and human smuggling has commenced in the 1990s. Increasing incidents of human smuggling has led the international community to take legal measures in prevention of human smuggling as an organized crime and protect the rights of smuggled migrants. An International legal framework has been developed to regulate the issue of human smuggling.

Italy and Austria played a pioneering role in the adoption of the UNCTOC. The main objective of the UNCTOC was to take measures against transnational organized crimes. International cooperation, creation of domestic legislations the adoption of extradition laws, mutual legal assistance and law enforcement cooperation are the measures critical for achieving the main objective. It is after the UNCTOC that two different protocols were adopted to address human trafficking and human smuggling.

Article 4 of the Protocol applies when the smuggling of migrants involves an organized group. The term organized criminal group is defined under article 2(a) of the UNCTOC as "*Organized criminal group" shall mean a structured group of three or more persons, existing for a period of time and acting in concert with the aim of committing one or more serious crimes or offences established in accordance with this Convention, in order to obtain, directly or indirectly, a financial or other material benefit".*

Article 3(a) of the Protocol has defined the smuggling of migrants as '*the procurement, in order to obtain, directly or indirectly, a financial or other material benefit, of the illegal entry of a person into a State Party of which the person is not a national or a permanent resident"*

In order to qualify a smuggling offence the above articles should be read together. To be characterized as human smuggling at least there must be an involvement of three persons.

Financial benefit is the core element to prove the crime. Some states have adopted domestic laws in line with Article 39a) of the protocol. *E.g:* BO10 v Canada (Citizenship and Immigration), (2015 SCC 58) the Supreme Court has concluded that sec. 37(1) (*b*) of the *Immigration and Refugee Protection Act a*pplies only to people who act to further illegal entry of asylum-seekers in order to obtain, directly or indirectly, a financial or other material benefit in the context of transnational organized crime. The acts of humanitarian

and mutual aid (including aid between family members) do not constitute people smuggling under the Act.

Both UNCTO and the protocol require States parties to take appropriate legal and other measures. The protocol defines human smuggling (Article 3 (a) and urges States to enact laws to punish human smugglers and protect the irregular migrant. A model law has been prepared by UN taking into consideration the various worldwide domestic laws in incorporating punitive provisions for smugglers. The model law also covers awareness creation about risks, international cooperation on resource sharing, exchange of information, rights to assistance, and protection for smuggled migrants.

Part II -Human Trafficking and Human Smuggling

Trafficking and smuggling are becoming big business and increasingly criminality is being integrated into this business. Both countries of origin, and destination countries are afflicted and these seriously impact on their international relations, security and economy. There is however, a marked difference between trafficking and smuggling.

Both trafficking and smuggling, are systems which facilitate movement from home country to destination countries in search of improved incomes and a better way of life.

Trafficking can take place within the country whereas smuggling needs to have crossing of borders. Trafficking victims do not violate law intentionally but smuggled migrants do so as they themselves collude in the process.

Trafficking draws apprehension and anxiety not only because of the manner in which a person enters into a country but also about his/her working conditions and whether he/she consented to the irregular entry and the working conditions (ILO, 2011) Trafficking is prompted by a sense of desperation and marked by severe forms of labor exploitation and also commercialized sexual abuse. (UNCTOC, 2000)

Smuggling is to facilitate and promote the illegal crossing of a country's border stealthily. Smugglers will therefore often be present and participate actively during the recruitment and transport processes. According to Salt (2000) trafficking involves a long-term

relationship between the trafficker and the trafficked person. It usually involves the trafficker, or associates, subjecting the trafficked person(s) to exploitative labour environments through removal of identity documents, withholding of payment, abuse and ill-treatment, and the continual threat of exposure to authorities and deportation.

Smuggling is clearly concerned with the manner in which a person enters into a country and with the involvement of third parties who assist him or her to active entry. A migrant enters into a contract with a smuggler to pay a fee to the smuggler. Often during smuggling process human rights become a casualty.

According to Theodore (Bilger as cited in Theodore Baird, 2013) there are some authors who argue that smuggled migrants cannot be reckoned as victims but should rather be considered and looked upon as clients because they seek a service from the smugglers through providing them with remuneration. In this context destination countries can look upon the smuggled migrants not as victims but as wrongdoers whereas trafficked migrants will be viewed as human rights victims. However the contention of Jandi, (2007) that "*quite often the smuggled migrants during the process of smuggling are applied the same criteria as are applied to trafficked victims thereby undergoing the same trauma is worthy of note".* The line between smuggled and trafficked migrants is rather blurred and changes also occur during operation.

Authors have expressed the view that there are considerable difficulties in making out difference between smuggling and trafficking (Louis Shelly, 2014). There are times when people who were smuggled after paying a considerable amount of money undergo sexual and labour exploitation and are accorded the same treatment as are given to trafficking victims (UNODC, 2006). The argument advanced that smuggled illegal migrants are often exposed to similar cases of danger or discomfort during the long journeys as trafficked victims has to be noted.

Notwithstanding the pitfalls and hazards occurring often under degrading conditions, there has been an increase in the number of persons who with their own consent are being facilitated to enter into countries using this illegal mode.

Those who organize trafficking do not insist on fee or an advance payment from victim. They collect fees from the well-connected business network. Victims are often told that they need not to make

any form of advance payment in order to be taken out of the country. There is some kind of pre- arrangement where these people are to be employed. The characteristic feature of human smuggling is not only collusion but also payment of fee to the smugglers to smuggle them out of the country. The victims are often dropped in the border of the destination country.

Because of the confusion between the different modes adopted for these two processes, obtaining information even from official sources is an encounter with a multitude of difficulties.

Studies have been carried out on these two distinct modes adopted by those who engage in the operation. Recognizing this already, laws have been developed in certain countries. However, awareness about this issue is inadequate and makes it rather difficult both to punish the smuggler as well as protect the victims.

Part III -Rights of Smuggled Migrants under International Legal Framework

International human rights law recognizes that all persons should be recognized as person before law are to be treated as equal before law and entitled for equal protection of law. Smuggled migrants are no exception. Joseph H Caren (2005) states that "*people ought to possess simply by virtue of being within in the jurisdiction of the state whether they have permission to be there or not and whether they are obeying the laws or not*". He points out while agreeing generally that the rights of irregular migrants should be protected, he specifically points out that right to security of one's person, right to food, medical care freedom, freedom of religion and freedom of speech and fair trial that are important rights of the irregular migrants. Smuggled migrants are also entitled to basic human rights regardless of their status. Their rights should be protected at all stages by those who intercept, identify and detain.

There is a vulnerability of irregular migrants to human rights abuses, discrimination, marginalization and exclusion. These are further accentuated by exploitation, and mistreatment by employers and also by official authorities. Smuggled migrants are also subject to sexual exploitation (Erick Gjerdingen 2009).

The woe of an irregular migrant begins from the time of departure up to their arrival at their destination and continues further. These

begin before departure, during transit at the border, within the country of destination and even after return to the country of origin.

During their journey, migrants often take great risks to circumvent official frontier or police controls, and some meet with death en route, sometimes under grim and appalling circumstances.

Smuggling is fought with many dangers. Sometimes they are captured by criminal gangs, (Andreas Schloenhardt and Kate L Stacey, 2013) There are many instances of being denied adequate food and also an absence of health care (ibid.,). Sometimes they are packed in ill ventilated containers and are subject to risk of being suffocated to death. As the vessels are not of accepted quality, there are instances of the entire vessels along with its crew and passengers being sunk in the sea.

Those who successfully enter into countries work under poor conditions. Cleo points (1999-2000) out those smuggled migrants are paid low wages. As those who volunteer themselves to be smuggled lack in legal status, they are put into a predicament of being not able to seek basic economic, social and cultural rights. Bethany Hastie (2009) contends that criminal based model has failed and therefore, human rights based model should be adopted in addressing this issue. Smuggled migrants undergo harassment at the work place and are also subject to sexual exploitation. Lack of legal status, results in a denial of most of the basic economic, social and cultural rights.

Some countries impose mandatory detention after apprehension. Andrew Trotte and Malt Garozo (2012) claims that the mandatory policy introduced by Australia to address human smuggling denies migrants rights and amounts to violation of international obligations undertaken through various international human rights instruments.

States are required to take measures in line with international obligations and responsibilities under international conventions relating to human rights, humanitarian law, and refugee law.

Article 3 (a), of the protocol defines smuggling as mentioned above. Article 3, (b), of the Protocol defines “illegal entry” The above two provisions refer to illegal entry into a country. When a migrant enters into another by violating the immigration law, he becomes an irregular migrant. Considering the vulnerable situation of smuggled

migrants, legal provisions have been incorporated into the protocol to provide minimum protection to the victims.

In relation to the human smuggling issue, both UNCTOC and the Protocol should be taken together. However, it is to be noted that some countries become party to the UNCTOC but do not ratify the protocol. States however are required to protect the rights of everyone under International human rights and customary international law. If a state does not ratify or accede to the protocol, then it is not possible to deal with human smuggling as it is the Protocol specially enacted for the purpose. E.g: Sri Lanka has ratified UNCTOC but is not a party to the protocol. Therefore, it can be said that Sri Lanka is not obliged under protocol to eradicate Human smuggling and protect the rights of smuggled migrants. However, it may be argued that SL is party to other major IHR instruments. However, it is only by ratifying the protocol that there will be a definite and clear recognition of the issues that arise out of human smuggling.

Article 6 of the protocol requires states to criminalize smuggling of migrants and to afford protection to the victims. Article 16 should be read together with article 6. Article 16 states as follows :"*in implementing this Protocol, each State party shall take, consistent with its obligations under international law, all appropriate measures, including legislation if necessary, to preserve and protect the rights of persons who have been the object of conduct set forth in article 6 of this Protocol as accorded under applicable international law, in particular the right to life and the right not to be subjected to torture or other cruel, inhuman or degrading treatment or punishment.*"

Article 9 requires states to safeguard the people on board. Article 16 of the Protocol urges the state parties to '*afford appropriate assistance'* to smuggled migrants. It also includes legislative and other measures too. States should protect migrants from physical violence. Further, article 6 emphasizes that smuggled migrants should be protected in accordance with relevant international treaties. State parties to the protocol have to ensure that smuggled migrants have access to consular services when they are detained.

According to Schenhardt & Stacy (2014) "*Article 16 does not confer any rights upon smuggled migrants nor does it create new obligations on state parties, beyond those already recognized in international humanitarian law*". This article does not give any specific guidelines as to the protection and violence against irregular migrants. There is

no explicit requirement that host country provides safe accommodation, or other types of protection. Article 16(3), '*affords appropriate assistance'* to migrants whose lives or safety are endangered by reason of having migrated. Article 16(4), recognizes the particular vulnerability of women and children.

Article 16(5) also implies an obligation on state parties to facilitate communication between smuggled migrants and relevant consulate in situations where the migrants entered the host country illegally. Although article 16 gives directions to host countries, it also gives discretion. Therefore, states can ignore these obligations.

Erick Gjerdingen (2009) points out that that smuggling protocol aims to impose criminal sanctions for smugglers not intending to protect human rights of the smuggled migrants as with the human trafficking victims. Obakato, (2005) remarks that "*the protocol fails to recognize the human rights aspects of migrant smuggling and that it shows little regard for 'political, social and economic solutions' to the problem.*" Erick Gjerdingen (2006) critically argues that the smuggling protocol mainly focuses on the punishing of the offenders, rather than protecting the smuggled migrants as compared with trafficking protocol.

The CSR and smuggling Protocol relating to the Status of Refugees should be read together. The principle of *non-refoulement* has been incorporated into Article 19 of the Smuggling Protocol. According to CSR, irregular migrants are not expelled from the country if their life is under threat. For example, illegal entry does not affect the right to seek asylum (BALI PROCESS, 2012).

The Model Law against the smuggling of migrants was developed by the UN to protect and to address the issue of human smuggling. UNCTOC has also included a number of provisions requiring state parties to take measures to assist and to protect smuggled migrants and witness (Article 25 of the UNCTOC). UNTOC emphasizes that regardless of their immigration status, smuggled migrants have the right to expect that their human rights and dignity should be upheld. Customary international law prevents states from punishing refugees merely entering into countries.

The gaps in UNCTOC and Protocol have been sought to be filled through other IHR. The IHR instruments have general and specific provisions with regard to the migrant's rights, irrespective of their status as to whether they are regular or irregular. Since there are shortfalls in the protocol, other human rights instruments have been

employed to fill the shortfalls for the protection of smuggled migrants.

Although not binding, article 3, paragraph 1, of the 1967 Declaration on Territorial Asylum and article 14 of the UDHR provide that every person has a right to seek and enjoy in other countries asylum from persecution.

Article 2 of the ICCPR and ICESCR urge the state parties to protect the rights of everyone, including irregular migrants without any manner of discrimination. This particular aspect was considered and has been clearly set out by the Human Rights Committee in its general comment 15. Other human rights instruments also ensure nondiscrimination in ensuring rights to non–citizens.

Article 1 of the CERD, Article 3 of the CEDAW, Article 7 of the International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families ensure the principle of non- discrimination with regard to non- citizens which includes smuggled migrants irrespective of their legal status. Article 2, paragraph 1, of CRC ensures that the child is protected against all forms of discrimination or punishment of the child irrespective of the status of the parents.

According to General comment 31 on Human rights committee, Article 7 of the ICCPR and Convention against torture (CAT) Article 3, specifically requires that "*States parties must not expose individuals to the danger of torture or cruel, inhuman or degrading treatment or punishment upon return to another country by way of their extradition, expulsion or refoulement.*" Similar provision is available under the CSR (Article 33).

Everyone is free from arbitrary arrest and detention (Article 9, ICCPR). Conditions of detention must comply with basic minimum human rights standards. There must be regular independent monitoring of places of detention to ensure that those standards are met. States should ratify the Optional Protocol to the CAT as this provides a strong legal basis for a regular and independent monitoring of places of detention.

Regardless of status of migrants, they are entitled to economic rights such as housing, health, food, education and sanitation. Article 12 of ICESCR ensures right to health of everyone. General Comment No. 14 (2000) (E/C.12/2000/4) the Committee stated that: "States

are under the obligation to respect the right to health, by inter alia, refraining from denying or limiting equal access for all persons, including prisoners or detainees, minorities, asylum-seekers and illegal immigrants, to preventative, curative and palliative health services; abstaining from enforcing discriminatory practices as a State policy".

Article 19, paragraph 2, of the protocol seeks to ensure that domestic laws pertaining to smuggling of migrants are not designed or applied in a manner that discriminates against smuggled migrants or irregular residents by reason of their status as such.

Scholars (Obakato, 2005) argue that the obligations in the Protocol are stronger than those in human rights treaties, and therefore, relying on the human rights framework undercuts the transnational obligations under the Protocol.

However, it is to be noted that some provisions in the Protocol are drawn from Human rights conventions. E.g: Obakato, points out that the model law developed by the UN draws certain provisions of the ICCPR. Example, the Model law states that the smuggled migrants are entitled to urgent medical care. This particular provision is drawn from the ICCPR.

A Combined reading of Article 16 of the Protocol and Article 28 of the CRC seems to show that the smuggled children are entitled to an education. The human rights treaty bodies have accepted the view that a violation of immigration laws does not deprive migrants of the fundamental human rights provided by human rights instruments nor does it affect the obligation of states to protect migrants in an irregular situation (UNODC, 2010).

Article 2 and 19 of the protocol drive to preserve the rights of smuggled migrants. Article 19 draws particular attention to the CSR. Article 33 of the CSR urges States not to return the people if they will undergo torture in the country of origin. This provision is similar to Article 7 of the ICCPR and Article 3 of the CAT.

Aljahani (2015) points out that, "*….although these mechanisms have been adopted to regulate the transnational organized crime, there are gaps and loopholes in these instruments*". Some literature suggests that major amendments are required for UNCTOC and protocol in terms of the definition of the crime, state parties' obligations and rights of irregular migrants.

In order to fulfill the said obligation under UNCTOC, Protocol and other IHR instruments, several measures are being taken by the States. Eg bilateral agreements are signed between countries to penalize the offence of human smuggling and protect the rights of smuggled migrants. (Eg: MOU between the Government of Australia and the government of Sri Lanka 2012). Resource and information sharing, and mutual legal assistance which are in place needs scrutiny. Some states have made legal and administrative arrangements Eg. Sri Lanka Mutual legal Assistance Act 2002 facilitates the investigations and trials in transnational crimes. However, closer examination has shown the limitations and constraints in these mechanisms.

Articles 16 of the protocol urges that where existing national law of state party does not conform to the protocol, amendments should be brought to preserve and protect the basic rights of smuggled migrants and illegal residents to protect against violence.

Part IV- Conclusion

Human smuggling incorporates and involves several countries such as the country of origin, of transit and destination. It, therefore, has an impact on the international relations, security and economy of all these countries. There would be migrants who make large payments to the smugglers and become enmeshed in the hazardous operation which sometimes pursues them even after they return to the country of origin. However, one is taken by surprise that despite the perils and pitfalls, there have indeed been cases of smuggled persons who after having been deported back make an attempt to be smuggled out once again. It is indicative of desperation and calls for a sympathetic understanding and humanitarian approach for the migrants.

International law on human smuggling has evolved since 1990s. Prior to this development, international human rights law had a role in addressing the issues of smuggled migrants. This study shows that the UNCTOC and the smuggling Protocol have provisions in regard to protecting rights of smuggled migrants. Even after development of these special international instruments, there are several gaps and loopholes which need urgent attention

The important lacuna is that these provisions are only directory in nature. One such example is that the protocol requires the states to take action to ensure rights of smuggled migrants but does not give

any mandatory directives to states. Thus, States can use discretionary power and disregard the protocol's objectives

The study clearly shows that the smuggling protocol focuses more on punishing the offenders rather than protection of rights of smuggled migrants.

Even States that have not ratified the UNCTOC and the smuggling protocol have obligations under other international human rights instruments. The recommendation is made that instead of depending on other human rights conventions, the protocol itself must enshrine the specific rights of migrants. They must be required to take legislative and non - legislative measures in order to ensure rights of smuggled migrants.

It must also be noted that these are countries which have not ratified relevant human rights conventions and therefore, these conventions cannot be invoked for protection of migrants.

Although UNCTOC may be ratified, this alone is insufficient to ensure rights of the migrants. It is necessary to ratify the protocol to provide meaningful protection.

Human smuggling is fraught with many dangers. There is uncertainty about the reception in the countries where the migrants enter. Countries involved in the process are put into great inconvenience and difficulties. While it is true that the countries of origin have to take meaningful steps to eradicate the root causes of smuggling one has to recognize the global dimension of this problem. The responsibility cannot be left only with the countries of origin only but also the countries of intended migration. Cooperation is required to handle this problem. Already some steps are being taken. But this has to be strengthened much more.

There is serious lacuna in that there is no treaty body that is charged with monitoring. Regular reporting by States and a watch dog function by a treaty body are urgently in need.

There is a Protocol provision which says that the States should not target the smuggled migrants as offenders. However, other provisions note that States have discretion to enact laws to punish them. This provision undermines the rights of smuggled migrants.

As a multiplicity of problems are caused by human smuggling, exchange of information and coordinated responses among the

affected countries have become indispensable and unavoidable. Coordination becomes all the more necessary as untold problems and hardships are caused to the migrants who are being subjected to human rights abuses, discrimination, marginalization and exclusion with problems persisting even after return to the country of origin. Although UNCTOC and the smuggling protocol aims to protect rights of smuggled migrants, the study shows that the convention does not impose any legal obligation. The terms are vague and the countries are allowed to take action as they wish.

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Convocation Address - 2016

Asha Singh Kanwar*

(May 2016, Commonwealth of Learning)

Honorable Chancellor,
Distinguished members of the OUSL,
Graduands,
Parents and friends,

It is a special privilege to receive a DLitt (honoris causa) from the Open University of Sri Lanka, a pioneer in distance learning in Asia and I thank the Vice Chancellor, Professor Ariadurai, and the university community for this great honour.

Convocation is a very important milestone in the life of an institution and I am really pleased to be a part of this happy occasion. OUSL was established nearly four decades ago and during this time has provided opportunities to thousands of men and women who are very diverse in terms of age, income and social background, to gain qualifications ranging from certificates to diplomas, degrees and doctorates. If the student cannot reach the institution, the institution is reaching the student in remote rural locations through flexible need-based programmes.

Even though access to quality higher education is still a distant dream for many young people globally, the demand for tertiary qualifications continues to grow. Sri Lanka has a broad system of higher education institutions: 15 public universities, 14 public higher education institutes and more than 40 private institutions. Yet, the Age Participation Rates of the 18-24 year-olds in higher education is about 17%, significantly lower than the OECD average of 40-50%, which is required for sustainable economic development in any country. Sri Lanka is exploring various ways of increasing access to quality higher education to its citizens.

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Open and Distance Learning or ODL is considered a viable option as it can enhance access, raise standards and reduce costs. UGC is supporting public universities to offer more distance and online provision. The National Online Distance Education Service or NODES access centres are another way of strengthening ODL infrastructure in the country. My organisation, the Commonwealth of Learning or COL, has supported the development of a draft policy on ODL for Sri Lanka which will create an enabling environment for distance and online learning to flourish and for more citizens to access quality higher education at affordable costs.

When Heads of Government decided to set up the organization, the Commonwealth of Learning in 1987, they saw this as an imaginative response to strengthening higher education in the developing world by making use of the potential of open, distance and technology enhanced education. Over the past three decades, we have witnessed an interesting trend. In 1988, there were only 10 open universities in the Commonwealth, of which three were in Canada and one in the UK. Twenty eight years later, that number has tripled. In Canada, the number has reduced from three to just one existing open university in the country. The growth has happened mainly in developing countries. India alone has 17 open universities and the five Open Universities in Commonwealth Africa will soon be joined by open universities in Botswana and Kenya.

Research shows that there is 'no significant difference' between distance and traditional classroom instruction in terms of learning outcomes; yet there is a lingering perception, especially in the developing world, that distance education is not as effective or adequate as campus-based learning. How do we address this gap in understanding and perception? It is interesting that the perceptions about the effectiveness of distance education in the developed countries are quite different from those in the developing countries. For instance, the Open University of the UK ranks regularly in the top five universities in the UK for student satisfaction and quality. Similarly in Canada, there is no distinction made between a campus or distance learning

qualification. Institutions in the developing world need to do much more to raise the profile and quality of open and distance learning.

However, in my view, the students who succeed from a distance learning institution, as you have done, are any employer's dream. Instead of studying full time in a campus university, you have often balanced the requirements of study with your family responsibilities and job requirements. You are multi-taskers who can do several things efficiently. It is because of your motivation, discipline and commitment that you are sitting here today to receive your hard-won qualifications.

I did my Master Degree studying at a distance since I was married at the age of eighteen. I come from a mountain community in India, where marriage rather than education was the ultimate goal for girls. But I wanted to study like my other friends who were going on to pursue further education in the big cities. I couldn't go to the big cities but I could still study at a distance. So distance education provided me with an opportunity I would otherwise not have had. In those days, getting a degree was quite enough and it opened many doors for me.

Today the world has changed and knowledge is multiplying at a rapid pace. What we learnt two or three decades ago is just not enough even for survival, let alone for success, in a highly competitive global market. Research indicates that you could have two to four careers in a lifetime. So if you enter the world of work, you will still need to continue to learn, unlearn and re-learn many different things during the course of your life. In short you need to be lifelong learners if you wish to succeed.

Unemployment is a global challenge, particularly youth unemployment which is 12.6% globally. Here in Sri Lanka, 20% of the young people are unemployed. And many countries face similar challenges. There is a great deal of emphasis on skills development in many Commonwealth countries. What are the skills required for employability? A study interviewed employers in five cities in South Asia: New Delhi, Mumbai, Bhopal; Lahore and Dhaka. Two clear themes emerged from the employer interviews in the three

countries. The first is the importance of skills such as leadership, communication, honesty/ethics, teamwork and flexibility. The second is the importance of being able to learn and the need for critical thinking and analytical skills (Burnett, p. 9).

One of the fundamental problems in our countries is the mismatch between education and employment. Are we teaching our students the skills they need for gainful employment? Experts warn that our education systems are churning out a workforce without the requisite skills for the new economy.

Linda Gratton in her book *The Shift--The Future of Work is already here* talks about five major forces that will fundamentally change the way we work. The five forces are: *one*, the force of technology; *two*, the force of globalization; *three*, the force of demography and longevity; *four*, the force of society and *five*, the force of energy resources.

How will we face these five forces? According to Gratton we need to make three shifts. The first shift involves making a move from being a shallow generalist to a serial master. What does this mean? Today we cannot succeed by simply being a 'generalist' who knows a little bit about this and that. We need to become 'serial masters' who have in-depth knowledge and competencies in a number of domains. In the past we could be experts in one field and that was quite enough. But today we may need to be experts in several areas. I started out as a professor of literature, moved into the field of education and now work in international development. With so much talent to choose from, what unique skill do we have to stand out? What role does our educational system have in helping us make this shift?

The second shift refers to making a transition from being an 'isolated competitor' to an 'innovative connector'. Instead of working alone we need to work collaboratively with others. This should not be difficult since the majority of the global population of 7 billion is connected in some way or another through technology. Traditionally, success at work was often attributed to personal drive and ambition. Now, it is becoming increasingly clear that we

need to have a combination of two skills – expertise in a chosen field and a strong network.

Geoff Colvin's recent book *Humans are Underrated* says that the high achievers in the twenty-first century will be 'relationship workers' as opposed to the 'knowledge workers' of the twentieth century. Robots will perform most tasks better than human beings, but it is humans who have social skills and empathy, can solve complex problems and are creative. How do we nurture these skills?

The third shift is from being a voracious consumer to impassioned producer. This includes a transition towards work that is more meaningful, where you can 'make things' and become an entrepreneur. It is more about moving away from a nation of job seekers to a nation of enterprising employees and employers. But that requires hard work.

Malcolm Gladwell gives an interesting recipe for how to become a world class expert in any field of activity – it is the 10,000 hour practice rule. For example, Bill Gates got the opportunity to do computer programming when still in Grade 8. He spent about 20-30 hours on the computer every week during the night and on weekends and he exceeded the 10,000 hour mark in about seven years. As Henry Ford puts it 'Genius is seldom recognized for what it is a great capacity for hard work.'

I am sure OUSL has equipped you with a robust capacity for hard work and discipline. OUSL has been constantly working on improving the quality of its provision for over a decade and COL has accompanied it on this journey. OUSL has gone through a successful completion of the COL Review and Improvement Assessment which will further enhance the 'culture of quality' within the institution. The Commonwealth of Learning values its collaboration with OUSL, and you will be pleased to know that a former OUSL staff member Dr. Ishan Abeywardena, now works for COL. We will continue this partnership as the University adopts new technologies and approaches to provide higher education relevant for the needs of the twenty-first century.

In closing, let me extend my warm greetings and congratulations to all of you, my fellow graduates. As you set out on the next steps of your journey, and as you cross many more milestones that mark your achievements, I am sure you will proudly recall the value of the opportunities that OUSL gave you, and how it empowered you for success. Thank you.

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