

Research Reach

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The journal invites previously unpublished original articles and review articles from students, faculty, and researchers in the fields of Nutrition and Dietetics, Human Development, Home Science Extension Education, and Textile Sciences.

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From the Editor's Desk

I apologize for the delay caused in bringing out the April 2018 issue, please bear with us. This journal has been serving as a forum for scientists, including young scholars to publish and share their research achievements. The journal covers original and authentic research and development work from all the branches of Home Science. It is widely subscribed to, by individuals and educational institutions across India. Sixteen volumes of the journal have been brought out so far since 2002. The most interesting achievement is that the journal is listed in the UGC list of approved journals.

The April 2018 issue of “Research Reach” brings to the readers an interesting blend of research articles in the field of community nutrition, innovations in food technology, human development and textile sciences contributed by researchers from the Department of Food Science & Nutrition, Human Development, and Textile and Fashion Technology. We have continued our efforts to include quality research articles from all domains of Home Science and its related fields and would greatly appreciate your contributions towards the same. Wish you all a rewarding sharing and learning research experience.

Dr. Geeta Ibrahim
Chief Editor

Research Reach

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DEVELOPMENT OF NATURAL FOOD PRESERVATIVE USING LACTIC ACID BACTERIA

Roopal Pritam Kataria*

The aim of this study was to extend the shelf life of fruit juices using natural compounds such as bacteriocins produced by Lactic acid bacteria. The Lactic acid bacteria (LAB) producing bacteriocins were isolated from fermented milk products and identified successfully as *L. plantarum* and *L. hilgardii*. The bacteriocin activity produced by the above species was compared with the standard strains *L. plantarum* and *L. lactis*. The antimicrobial activity of the crude bacteriocins was determined against the standard test organisms and the isolates of food spoilage organisms. The bacteriocin activity was found to be stable over a wide range of temperature and pH but was lost upon treatment with proteolytic enzyme. Antibiotic Sensitivity Testing (AST) was performed for these organisms using standard antibiotics. The test organisms were found to be more susceptible to the bacteriocins obtained as compared to the standard antibiotics. Minimum Inhibitory Concentration i.e. MIC of benzoate and bacteriocins was determined and the sub-lethal concentration of these agents was added to the fruit juice prepared. The efficiency of the chemical preservative i.e. benzoate was compared with the natural preservatives i.e. bacteriocins by performing SPC counts at regular intervals. The bacteriocins were found to be more effective than chemical preservatives in reducing the bacterial load in the prepared juice samples. Up to 82% reduction in bacterial count was reported in fruit juice preserved with bacteriocin whereas the reduction in bacterial count reported in fruit juice preserved with benzoate was 63%.

Keywords: LAB, Bacteriocins, Antimicrobial Activity, Natural Preservatives

INTRODUCTION

The most challenging task for a food industry is the ability to store large quantities of food. Microbial spoilage of food during storage can lead to heavy economic loss. In India, production of different varieties of fruit juices is carried out on a very large scale to meet the ever-increasing demand of the consumers. To extend the shelf life of these products chemical food preservatives have been used since quite a long time in the history of processed food. These chemical food preservatives are found to have many health hazards ranging from mild headaches to most serious diseases like cancer effects (Anand et al, 2013). With the increase in the awareness of food safety consumers are now demanding products containing natural preservatives. For these reasons, the use of bio-preservatives in food has in recent years, attracted considerable interest as shelf-life extenders. (Galvez et al, 2007)

Biopreservation can be defined as the extension of shelf life and food safety by the use of natural or controlled microbiota and/or their antimicrobial compounds (Caplice et al, 1999). Several compounds have been proposed and tested for antimicrobial activity in food preservation including organic acids such as sorbate, propionate, benzoate and enzymes such as lysozyme. The effect of antimicrobial agents on the spoilage organisms is widely diverse. There is no single antimicrobial agent that effectively functions against all spoilage and pathogenic microorganisms.

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Thus, novel and complementary food preservation technologies that comply with these demands are continuously sought and explored (Anand, 2013)

Lactic acid bacteria (LAB) have been used as microbial preservatives for ages in order to extend the shelf life of foods. The preservative effect exerted by LAB is mainly due to the production of organic acids, carbon dioxide, ethanol, hydrogen peroxide and diacetyl, fatty acids, phenyllactic acid, bacteriocins and antibiotics. LAB may also compete for nutrients or space with spoilage microorganisms thereby exhibiting antagonistic effects against spoilage and pathogenic bacteria (Caplice, 1999). The LAB bacteriocins have many attractive characteristics that make them suitable candidates for use as food preservatives. They are protein in nature, non-toxic and non-immunogenic. They are generally thermo-resistant (can maintain antimicrobial activity after pasteurization and sterilization), and have broad bactericidal activity affecting most of the Gram-positive bacteria and some, Gram-negative bacteria including various pathogens such as *L. monocytogenes*, *Bacillus cereus*, *S. aureus*, and *Salmonella*. They are considered “Generally Recognized As Safe” (GRAS) (Settanni, 2008; Galvez, 2007; Goyal, 1996).

Bacteriocins and bacteriocin-producing strains of lactic acid bacteria (LAB) have been the focus of extensive research in recent years due to their potential as biopreservatives. A lot of studies have focused on the inhibition of spoilage-causing and foodborne pathogens using bacteriocins. Their applications offer a good alternative to chemical preservatives. (Sharma, 2014; Nwuche, 2013; Pratush, 2012; Sankar, 2012; Sezer, 2009; Campos, 2006; Todorov, 2003) The antibacterial potential of bacteriocins has been tested in milk and dairy products against various other pathogens and food spoilage organisms (Shokryazdan, 2014; Yang, 2012). Various studies have been carried out on the use of bacteriocins as natural preservatives to extend the shelf life of food products like fish, meat, cheese, fruits and vegetables (Sharma, 2014; Pratush, 2012; Udhayashree, 2012).

The present study aims to develop the use of natural preservatives such as bacteriocins as an alternative approach to chemical preservatives like benzoate, currently used to prolong the shelf life of fruit juices for long-term preservation. The use of bacteriocins in the food industry can help to reduce the addition of chemical preservatives as well as the intensity of heat treatments. Thereby, resulting in foods which are more naturally preserved and richer in organoleptic and nutritional properties.

MATERIALS AND METHODS

1. Sample Collection

Fermented milk products i.e. curd and lassi samples were purchased from a local dairy for isolation of lactic acid bacteria. Spoilt fruit samples were collected from local fruit market for isolation of spoilage-causing organisms. Good quality pineapples were purchased from the same fruit market for the preparation of juice.

2. Isolation and identification of bacteriocin producing LAB

The bacteriocin producers LAB were isolated from curd and lassi samples. The samples were diluted with sterile distilled water and 0.1 ml of the dilution was plated on MRS agar. After incubation for 24 hours at 37 °C, typical colonies were isolated and purified. The isolates were identified up to the genus level on the basis of their morphological, cultural, and physiological characteristics such as gram character, oxidase test, utilization of citrate as a sole carbon source, and catalase test (Harrigan, 1966). Species identification was carried out at Suburban Diagnostics using ANC card in the Vitek 2 Compact automated identification system.

3. Isolation of food spoilage organisms

Spoilt fruit samples were rinsed with sterile saline to eliminate the surface flora. 1 gm of the fruit from spoilt portion was then homogenized with 9 ml of saline. The homogenized sample was further diluted suitably so as to obtain isolated bacterial colonies on plate medium. Bacteria were recovered by spreading aliquots of 0.1 ml of the dilutions onto duplicate plates of Nutrient Agar. The inoculated plates were incubated at room temperature; and after 24 days of incubation, the colonies developed were studied. Screening of the isolates was carried out based on its morphological and biochemical characteristics. Four representative isolates of the different bacterial group were selected for further studies (Settanni, 2008; Harrigan, 1966).

4. Bacteriocin production and extraction

Lactic acid bacteria isolated from natural samples i.e. curd and lassi were used for bacteriocin production. This eliminates the need to perform the safety studies further. For comparative analysis, standard strains of *Lactobacillus plantarum* and *Lactobacillus lactis* were also used. Large-scale production of bacteriocin was carried out in MRS broth. The producer organisms were isolated on MRS agar plates to check for its purity. For the development of seed culture, pure colonies isolated on the plate were inoculated in 10 ml of MRS broth and incubated at 37°C. 10 ml of the overnight seed culture was inoculated in 100ml of MRS broth. After incubation at 37°C for 48 hours, cell-free supernatants (CFS) were collected by centrifugation at 5000 rpm for 15 min at 4°C. The pH of the CFS was adjusted to 6.5 with 1N NaOH to eliminate the effect of organic acids (Damania, 2016).

5. Antimicrobial activity of bacteriocins against test organisms

Antimicrobial activity of the bacteriocins in CFS was determined against the selected food spoilage organisms and the standard test organisms *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus* and *Bacillus cereus*. Agar well diffusion assay method was used for the antimicrobial studies. 24-hour old cultures suspensions (0.1 OD) of test organisms were bulk seeded into the sterile Nutrient agar. A sterile cork borer of 6mm diameter was used to make wells on the medium. 4 wells were made in each of the plates. 0.1 ml of the CFS was introduced into the different wells. Pre-diffusion was carried out for 30 mins at 4°C. The plates were then incubated at 37°C for 24 hours. The antimicrobial activity was determined by measuring the diameter of the zones of inhibition around the well (Damania, 2016; Udhayashree, 2012; Campos, 2006).

6. Characterization of bacteriocins

6.1. Effect of temperature

The effect of temperature on bacteriocin stability was determined by exposing 5 ml aliquots of CFS at 4°C, Room temperature, 37°C, 63°C and 100°C for 30 minutes. Agar well diffusion method was performed to determine the residual activity in the heat-treated CFS. (Damania, 2016)

6.2. Effect of pH

To check the pH stability of the bacteriocins, 5 ml aliquots of CFS was taken in sterile tubes and were adjusted to pH values of 2, 4, 7 and 9 using 1N HCl or 1 N NaOH. After incubation at room temperature for 30 minutes, pH in each tube was readjusted to 6.5 and the antimicrobial activity was determined by agar well diffusion method. (Damania, 2016)

6.3. Effect of proteolytic enzyme

5 ml of CFS was taken in a test tube and was treated with trypsin-chymotrypsin enzyme (10AU/ml) at pH 7. The test tubes with and without enzyme (control) were incubated at 37°C for 1 hour. After incubation, the enzyme was denatured by heating the tubes at 100°C for 5 minutes. Both the test treated and untreated samples (control) were assayed for antibacterial activity by agar well diffusion method. (Udhayashree, 2012)

7. Antibiotic Sensitivity testing

AST was performed by disc diffusion method for the standard test organisms *Escherichia coli*, *Salmonella typhi*, *Staphylococcus aureus* and *Bacillus cereus* and also the food spoilage isolates. The standard antibiotics disc used for gram-positive organisms includes Penicillin, Methicillin, Vancomycin and Clindamycin. For the gram-negative organism, Ampicillin, Carbenicillin, Cephalothin and Trimethoprim were used. Mueller Hinton agar plates were inoculated and incubated at 37°C for 24 hours. The inhibition zone diameters were recorded and the results were interpreted on the basis of NCCLS guidelines. (Kastner, 2006)

8. MIC of benzoate and bacteriocins

MIC of sodium benzoate and bacteriocin CFS was determined for the food spoilage isolates. Dilutions were performed for 10% sodium benzoate and 20% bacteriocins using a sterile Nutrient Broth. Overnight grown culture suspension of food spoilage isolates (0.1 OD) was inoculated in the tubes and incubated at 37°C for 24 hours. The MIC was recorded as the lowest concentration of preservatives that resulted in no visible growth after incubation. (Meghrou, 1999)

9. Preparation of fruit juice and its preservation using chemical and natural preservatives

500 ml of fresh pineapple juice was made in the laboratory and pasteurized at 63°C for 30 minutes. The juice was then cooled immediately and dispensed in separate sterile flasks. The natural preservative i.e. bacteriocin at 15% concentration was added in the juice sample based on its MIC value. Similarly, chemical preservative i.e. 5% sodium benzoate was added to another flask for

comparative studies. Control flask was maintained with no added preservatives. All the flasks were preserved at 4°C for a period of 5 days. (Joshi, 2006; Grande, 2005)

10. Efficiency of added preservatives

Standard plate count, Yeasts and mold count, and the Coliform count were determined for the juice immediately after its preparation. Fresh juice was serially diluted and plated on plate count agar and Sabouraud's agar for bacterial and fungal counts and the plates were incubated at RT for 48 hours. Coliform count was performed using Violet Red Bile Agar and the incubation conditions maintained for the same were 37°C for 24 hours. To determine the efficiency of the preservatives, standard plate count was performed from each flask after 1 day, 3 days and 5 days. The counts obtained were compared with the initial load and the percentage reduction was calculated. (Joshi, 2006; Grande, 2005)

RESULTS

1. Isolation and identification of bacteriocin producing LAB

Lactic acid bacteria were isolated from curd and lassi samples on MRS agar plate. The isolates obtained on plates were screened further. For each sample colonies negative for catalase test were gram stained. The isolate obtained from curd was found to be gram-positive, non-spore forming punctiform rods whereas the gram staining of the isolate obtained from lassi sample was gram-positive, irregular, non-sporulating long rods, appearing in chains or filaments (Fig 1). Based on morphological and biochemical tests, the isolates were identified as belonging to lactic acid bacteria (LAB). Further species identification was carried out on Vitek 2 compact system. Based on the results of 64 biochemical tests performed on ANC card the LAB isolated from curd and lassi samples were identified as *Lactobacillus plantarum* and *Lactobacillus hilgardii* respectively.

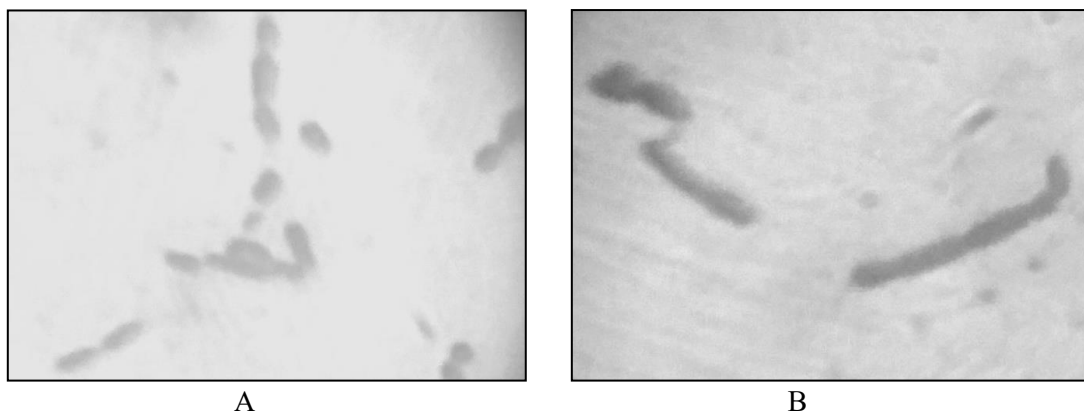


Figure 1: Gram staining of isolates obtained from a) curd and b) lassi

2. Isolation of food spoilage organisms

The spoilage-causing organisms were isolated on Nutrient Agar plates after surface disinfection of fruits. 11 colonies were obtained out of which 4 (F1, F2, F3, F4) were selected for further studies based on their properties. Isolates F1 and F2 were selected so as to represent the gram-negative bacteria while F3 and F4 belong to gram-positive bacteria. All four isolates were catalase positive and ferment glucose. Hydrolysis of starch, lipids and gelatin was carried out by all the isolates. F1 produce red pigment and was found to be gram negative short and slender rods. Isolate F2 produce mucoid colonies and was observed as gram-negative, capsulated, plump coccobacillary rods. F3 colonies produce pale yellow pigments and it was able to tolerate high salt concentration up to 7.5%. On gram staining, F3 isolate was observed as gram-positive cocci in clusters and tetrads. The F4 isolate produces white, irregular, rough and dry colonies on Nutrient Agar. It was found to be gram-positive sporulating rods, arranged in diploids. They produce sub-terminal spores.

3. Bacteriocin production and extraction

The isolates obtained from fermented milk products i.e. *L. plantarum* and *L. hilgardii* and the standard strains *L. plantarum* and *L. lactis* were used for bacteriocin production. The producer strains were grown in MRS broth. After 48 hours of incubation, centrifugation was carried out to obtain bacteriocins as cell-free supernatant (CFS). The pH of the CFS was adjusted to 7 using NaOH and it was used for further analysis.

4. Antimicrobial activity against test organisms

The CFS obtained from all 4 species was found to inhibit the test organisms *E. coli*, *S. typhi*, *S. aureus*, *B. cereus* (Fig 2) as well as the spoilage-causing organisms F1, F2, F3, and F4 (Fig 3). The bacteriocin produced by *L. plantarum*, standard as well as the isolate, showed maximum activity against all the test organisms. The test organisms showed varied susceptibility to the bacteriocins with *E. coli* and *B. cereus* being the most susceptible ones. Amongst the food spoilage organisms, the gram-positive rods and cocci exhibit more susceptibility than the gram-negative bacteria.

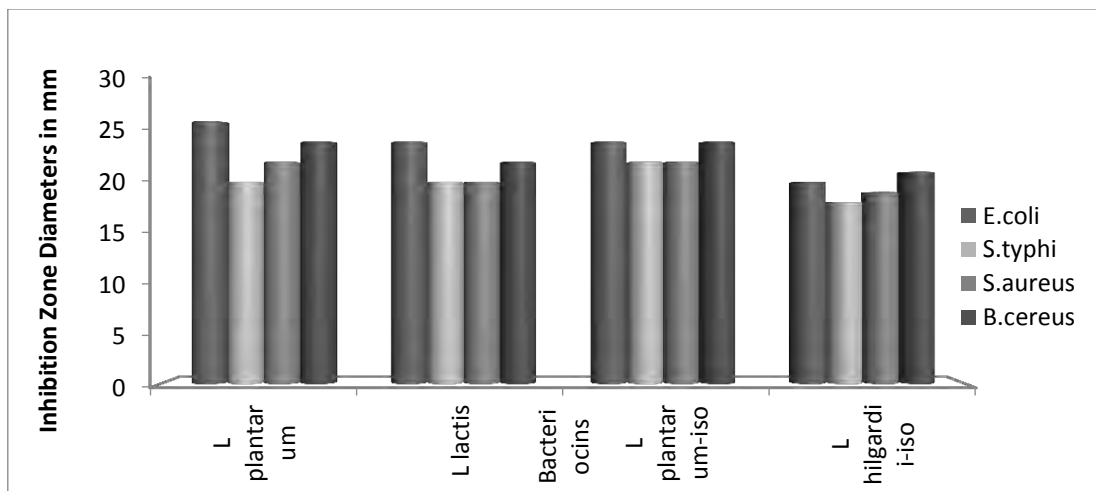


Figure 2: Antibacterial activity of bacteriocins against standard test organisms

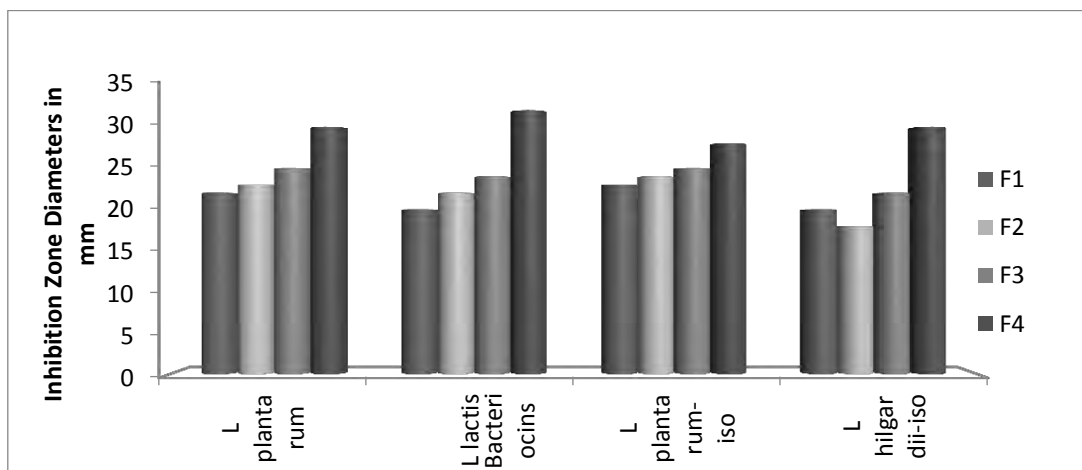


Figure 3: Antibacterial activity of bacteriocins against food spoilage organisms

5. Characterization of bacteriocins

5.1. Effect of temperature

The bacteriocin activity for all four types was found to remain stable at a wide range of temperatures ranging from 4°C to 100°C, with the maximum activity reported at 63°C (Fig 4). This suggests that the activity of purified bacteriocins remain unaffected in fruit juices preserved at low temperatures and also in the pasteurized product. Thermo-stability of bacteriocin at high temperature makes it possible to sterilize the food products even at room temperature, thus avoiding their storage at low temperature.

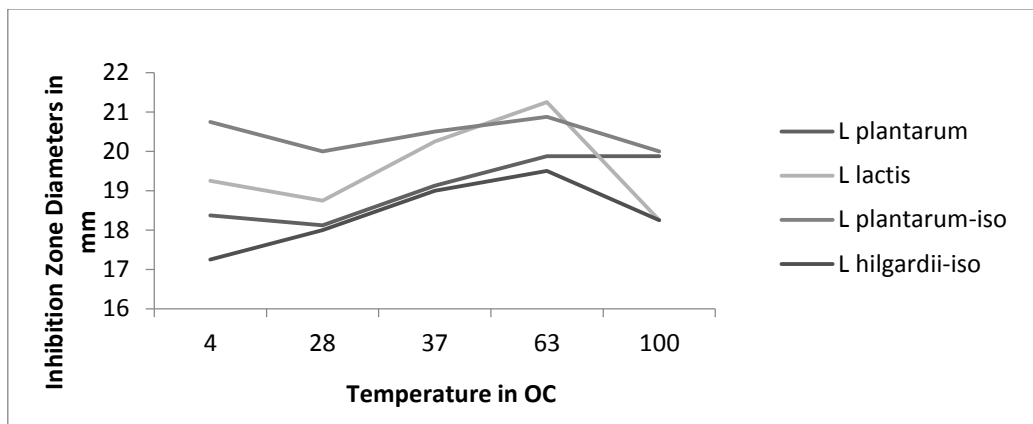


Figure 4: Effect of temperature on bacteriocin activity

5.2. Effect of pH

The activity of the bacteriocin remained stable at a very narrow pH range. The maximum activity of bacteriocins obtained from *L. plantarum* (standard and isolate) was reported at pH 4, whereas the optimum pH for bacteriocins obtained from *L. lactis* and *L. hilgardii* was reported at 7 (Fig 5).

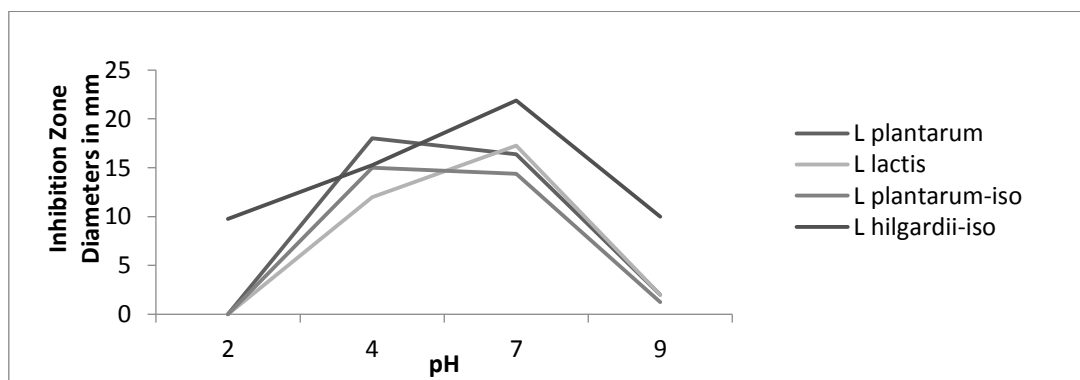


Figure 5: Effect of pH on bacteriocin activity

5.3. Effect of proteolytic enzyme

Antibacterial activity of the bacteriocins was destroyed when treated with the proteolytic enzyme, trypsin-chymotrypsin mixture (Fig 6), indicating that the nature of the isolated bacteriocins is proteinaceous. Therefore, it can be broken down by gastric juices, thus making it completely safe for human consumption.

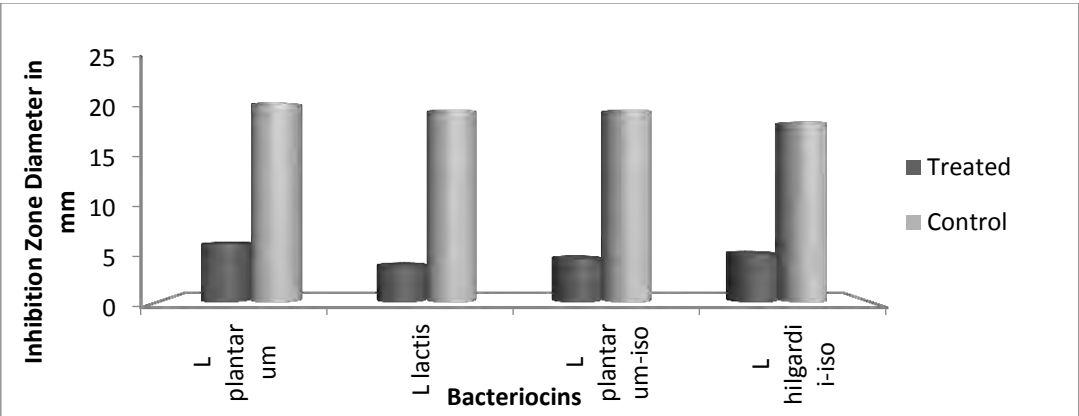


Figure 6: Effect of proteolytic enzyme on bacteriocin activity

6. AST

AST was performed for the test organisms using standard antibiotics. The isolates from spoilt food samples were found to be resistant to some of the standard antibiotics like ampicillin, methicillin, clindamycin, and vancomycin. The gram-negative bacterial species were found to be more susceptible to standard antibiotics as compared to the gram-positive bacteria (Fig 7-8). These isolates exhibit greater sensitivity to bacteriocins produced by the LAB.

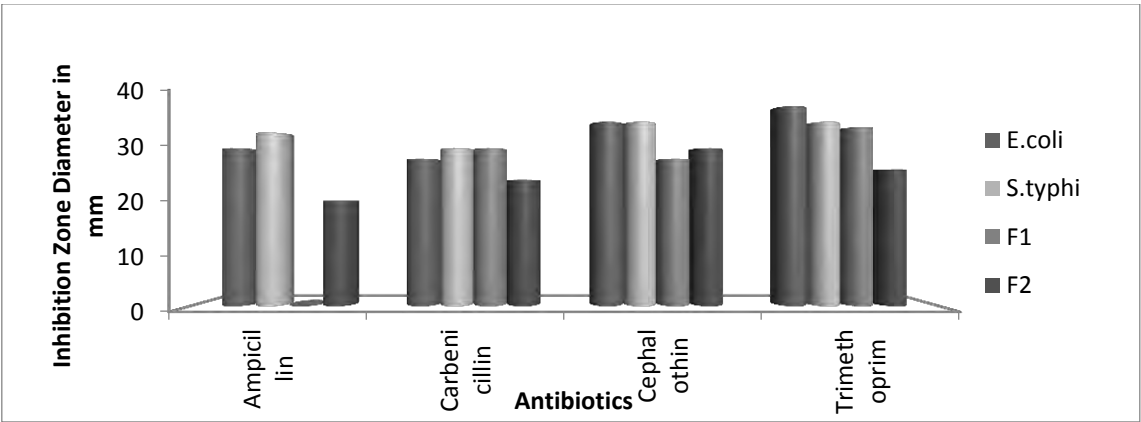


Figure 7: Antibiotic Susceptibility testing of gram negative bacteria

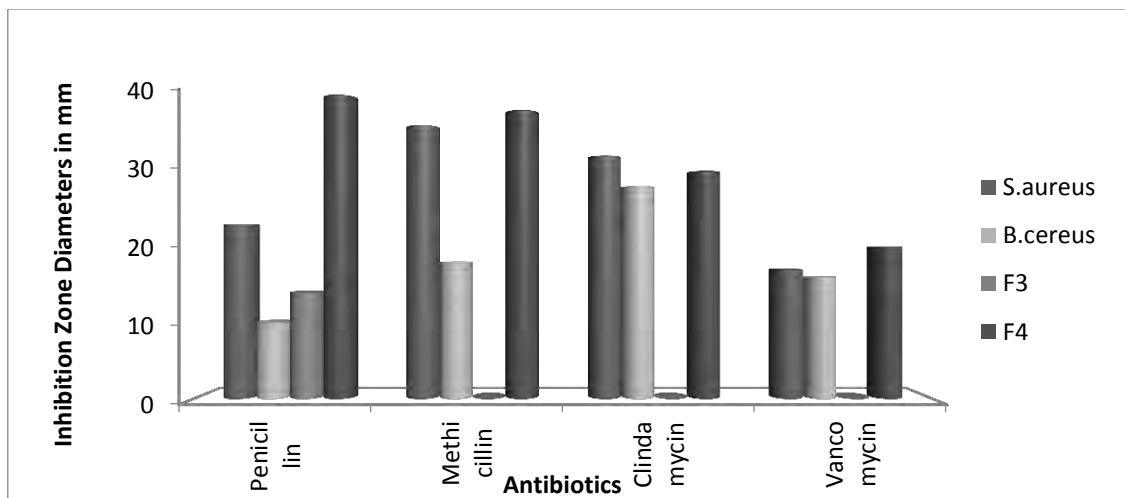


Figure 8: Antibiotic Susceptibility testing of gram positive bacteria

7. MIC of preservatives

MIC was performed to determine the minimum concentration of bacteriocins and benzoate that can be added to the fruit juices for preservation. The isolate F1 was found to be the most sensitive species to all the agents tested where F4 was the least sensitive except for the bacteriocin produced by *L. plantarum*. The MIC of benzoate and the bacteriocins obtained for various spoilage organisms is reported in Fig 9.

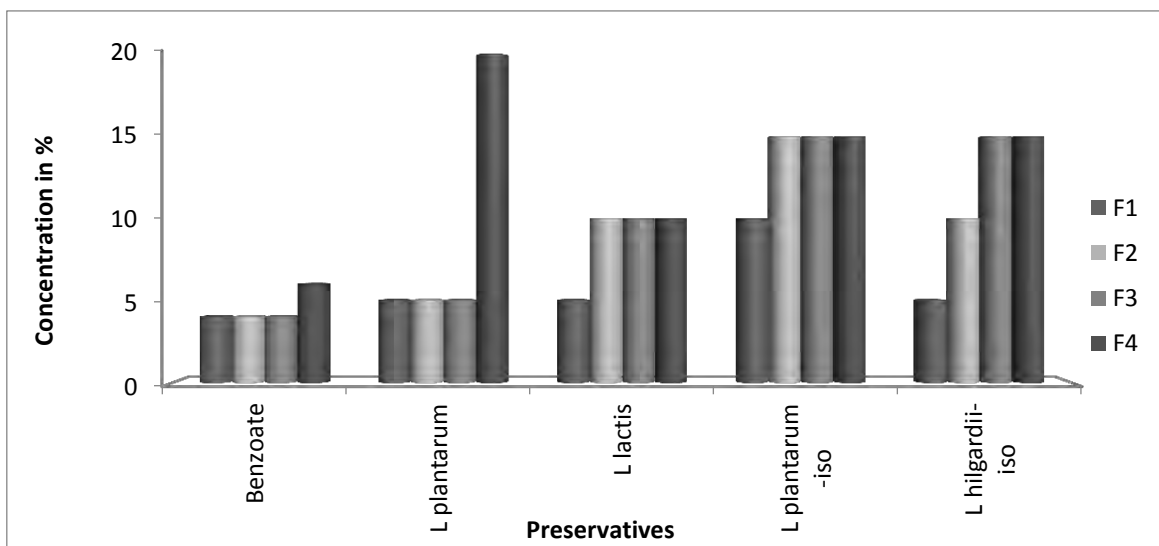


Figure 9: MIC of benzoate and bacteriocins for food spoilage organisms

8. Preparation of fruit juice and its preservation using chemical and natural preservatives

Fresh pineapple juice was prepared and pasteurized. Based on the MIC results obtained, fruit juices containing preservatives was prepared. Either 5% concentration of benzoate or 15% concentration of bacteriocins was added to the pasteurized product. The efficiency of the preservatives was determined at regular intervals up to 5 days.

9. Efficiency of added preservatives

Standard plate count, coliform count, and yeast and mold count of samples inoculated with benzoate and bacteriocins as preservatives were determined on Day 0 immediately after addition of preservatives. There was no growth of coliforms, yeasts and molds. As per microbial guidelines for food, given by Center for Food Safety, products such as fruits beverages having SPC count greater than or equal to 10^7 are unsatisfactory for consumption. Presence of coliforms and yeasts and molds are unacceptable. Thus, for further studies, only SPC was performed on Day 1, 3 and 5. The results obtained for SPC count is reported in Fig 10. Day-wise reduction in SPC count was reported in fruit juices containing preservatives as compared to control sample (Fig 11). The mean reduction after 5 days reported for fruit juice without preservative was 18% whereas 63% reduction was reported for juice preserved with benzoate. The mean reduction reported for fruit juices with 15% bacteriocins when added as preservatives were 72%, 81.56%, 82.15%, 78% for the producer organisms *L. plantarum* (standard), *L. lactis*, *L. plantarum* (isolate), *L. hilgardii*, respectively.

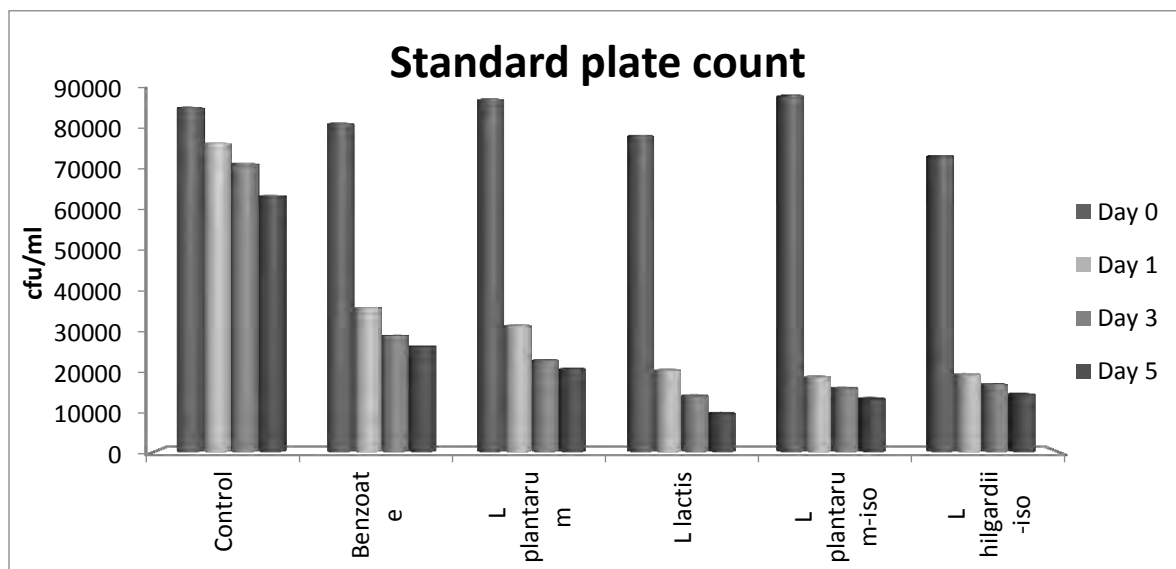


Figure 10: Efficiency of preservatives in fruit juice

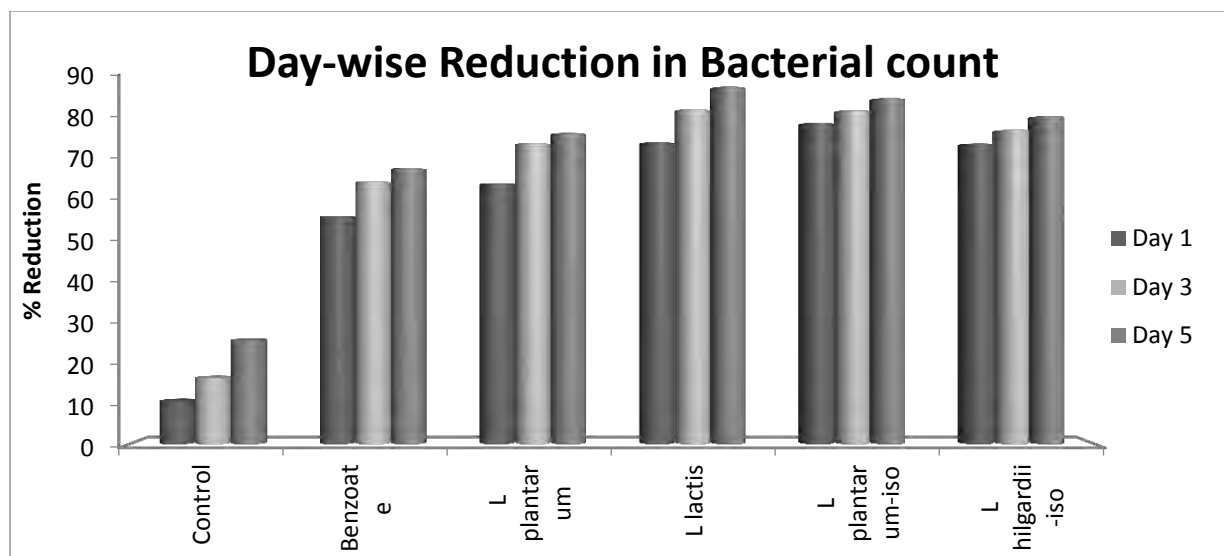


Figure 11: Percentage Reduction in bacterial count in preserved fruit juice

DISCUSSION

Several types of bacteriocins produced by LAB has been obtained, characterized and identified. Some of the common Lactobacilli species producing bacteriocins isolated from food source include *L. lactis* (fermented milk products, fish, radish fermentation, and barley beer), *L. plantarum* (cow's milk, cheese, carrot fermentation, barley beer), *L. casei* (raw milk, probiotic drink), *L. paracasei* (barley beer), *L. pentosus* (barley beer), *L. brevis* (ogi), *L. acidophilus* (human milk, ugba), *L. fermentum* (human milk, chicken intestine). The activity of bacteriocins produced by different LAB depends on the chemical composition and physical conditions of food. The major factors affecting bacteriocin activity includes pH of the food, bacteriocin binding to food components, adsorption to cell or protein, activity of proteases and other enzymes. (Nwuche, 2013; Pratush, 2012; Sankar, 2012; Todorov, 2003)

Antibiotic resistance has been studied in various species of bacteria isolated from fruits and vegetables. According to Schwaiger et al, 2011 resistance rates of bacteria isolated from farm samples were found to be higher than those of the retail markets. Many of the coliform species are also reported to be multi-drug resistant. (Nipa, 2011) The bacteriocins of LAB isolated from food products such as meat, milk and dairy foods exhibit higher antimicrobial activity against spoilage-causing organisms and foodborne pathogens such as *Listeria*, *S. aureus*, *Enterococci*, *E. coli*, *Salmonella*. (Pratush, 2012; Sankar, 2012; Campos, 2006; Todorov, 2003) Sankar et al, 2012 reported that bacteriocin from *Lactobacillus plantarum* isolated from raw cow's milk sample possesses broad range of antibacterial activity against foodborne pathogens. In the study carried out by Ogunbanwo et al (2003), bacteriocin of *L. plantarum* isolated from Nigerian fermented food products exhibited broad-spectrum activity, inhibiting 28 out of 32 strains tested.

Several studies revealed that bacteriocins produced by *L. paracasei*, *L. lactis*, *L. plantarum* and other LABs withstand high temperature up to 121°C for 20 min and are effective in the pH range of 4-6. (Damania, 2016; Sharma, 2014; Udhayashree, 2012; Joshi, 2006) The sensitivity of LAB bacteriocins to proteolytic enzymes like trypsin, chymotrypsin has also been reported in multiple studies. (Damania, 2016; Joshi, 2006)

In a study carried out by Pratush et al, 2012 the bacteriocin produced by *L. lactis* isolated from fermented milk products was used as a biopreservative. The bacteriocin was reported to be stable at low temperature and at acidic pH 2 to 6 thereby rendering it to be used in acidic foods as biopreservative. The preservative effect of bacteriocin, when compared to sodium benzoate, was found to be better in acidic products like fruit juices.

Joshi et al, 2006 also observed the biopreservative potential of purified bacteriocin from isolate against *B. cereus* and found that the preservative effect in fruit juice increased with the increase in the concentration of bacteriocin. Eighty-seven per cent reduction of *B. cereus* population was observed in juice at a concentration of 0.5 %. 92% reduction of total bacterial load in fruit juices preserved with bacteriocin was also reported.

Grande et al, 2005 evaluated the stability of enterocin AS-48 in fruit and vegetable juices as a preliminary step for its food applications. Under refrigeration storage, the bacteriocin was stable for at least 15 days in fresh fruit juices. Stability of enterocin AS-48 did not change for up to 120 days in case of refrigerated commercial fruit juices. The results also suggested that loss of activity of enterocin AS-48 was reduced by increasing its concentration, diluting the juices or heat pretreatment of juices. The bacteriocin was found to be compatible with food-grade dyes and thickening agents, making it suitable as a biopreservative in food.

CONCLUSION

In conclusion, from a practical point of view, it can be stated that the bacteriocins produced by Lactic acid bacteria which are safe and can be used in the preservation of food products. Concentrated preparations of bacteriocins can be incorporated into foods. The use of bacteriocins, either alone or in combination with mild physicochemical treatments and low concentrations of traditional and natural chemical preservatives, can play a defining role in the control of undesirable flora, as well as in the establishment of beneficial bacterial populations.

Thus exploitation of bacteriocinogenic cultures, as well as their pure bacteriocins can potentially be an efficient way of extending shelf life and improve the food safety through the inhibition of spoilage and pathogenic bacteria without altering the nutritional quality of raw materials and food products. This can be an alternative to satisfy the increasing consumer's demands for safe, fresh-tasting, ready-to-eat, minimally-processed foods and also to develop "novel" food products.

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DEVELOPMENT AND EVALUATION OF A THEORY BASED NUTRITION EDUCATION INTERVENTION FOR GRADUATE CONSUMERS IN MUMBAI

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Nutrition transition presents an eminent threat to the health of Indians in the form of epidemic proportions of Diet-related Non-communicable diseases (DR-NCDs). These are signalling risky health-related behaviour. Nutrition messages on food labels have the potential to contribute to the achievement of public health objectives of reducing DR-NCDs. Several Indian studies indicate the need for educating consumers regarding nutrition. The aim of the study was to develop and test the effect of a consumer-centric Nutrition Education Intervention (NEI) on the comprehension and behaviour of adult graduate consumers from the City of Mumbai. The curriculum developed was grounded in the Constructivist theory. The Analyze, Design, Develop, Implement and Evaluate (ADDIE) model of instructional design has been used for the implementation. A convenience sample comprised of forty-six consumers consented to participate in the experimental study. Parallel pre and post-tests were developed to assess the effect of the NEI. The group was subjected to the NEI. The pre-test and post-test scores were evaluated by the paired t-test, which revealed statistically significant difference ($p < 0.05$) in the comprehension and self-reported behaviour of the consumers. This NEI can be used for adult consumers to empower them to comprehend nutrition messages on food labels optimally and make health-promoting choices.

Keywords: Consumer education, Nutrition messages, Food Labels

INTRODUCTION

India has one of the highest rates of DR-NCDs and associated risk factors. (Mishra et al, 2011) This has been mainly attributed to changing lifestyles, leading to a nutrition transition. Increased affordability and easy availability have resulted in increased consumption of processed and convenience foods over a few decades in India. (Popkins et al 2012, 2013) This has left us reeling with epidemic proportions of Diet-related Non-communicable diseases (DR-NCDs). The Food Standards and Safety Authority of India (FSSAI) regulate Food Labels and intend its use as means of communicating nutrition information to consumers. (FSSAI, 2011) It is proposed that consumers use these for reaching health-promoting choices. Current research in India reveals that consumers find the nutrition information on labels confusing and technical to comprehend. (Singla, 2010, Archana et al 2015, S. Vemula et al, 2014, Gavaravarapu et al, 2016)

This is one of the reasons why consumers are not optimally using the label information. Only around 30% of Indians report using the information. (Kumar, 2018, S. Vemula et al, 2014) Many studies have recommended the need for nutrition education. (Singla, 2010, Singh et al 2015, S. Vemula et al, 2014, SubbaRao et al, 2016) During the literature search for Nutrition education curriculum with regard to the use of nutrition messages on food labels for adult consumers in India, the investigator has not

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come across any material till date to the best of her knowledge. Clearly, there seems to be an urgent need for a consumer-centric theory-based nutrition education curriculum.

In our Indian culture, food is enjoyed and celebrated. Food from a consumer's point of view is about freedom of making food choices. Hence the proposed NEI may support consumers to build their own perspectives on health-promoting food choices rather than directly teaching those concepts of nutrition in a matter of fact manner. The theory of the Constructivist approach claims that individuals learn best by building their own realities. (Bodner, 1986, Ackermann, 2015) The intervention was designed to learn through a series of face-face with practical strategies for optimizing wise food choices by using food labels on Ready To Eat (RTE) pre-packaged foods. Consumers need challenging new opportunities to enhance their comprehension of nutrition messages on food labels. Consumers should be encouraged to apply their learning under stimulated settings. This may motivate learners to apply the nutrition concepts from the classroom lessons in real life situations. Another aspect of the curriculum that incorporates the constructivist theory includes the facilitator selecting common scenarios that are experienced by the learners to be the context of the learning. The facilitator then nudges the learners from the sideline to narrate their personal experiences with the group. At the end of shared learning, the facilitator summarises the learning with the reference to the overall learning objectives of the corresponding unit. This aspect has been integrated into the curriculum to facilitate the process of use of nutrition messages for reaching health-promoting choices.

It is also proposed that nutrition education can be complementary to the main academic programme if a few academic hours are allotted to promote nutrition key messages. The proactive interaction between the non-nutrition background learners and nutrition educators may result in exciting new learning models, which may benefit students, educators, colleges, families and communities.

Constructivist Theory: Learning through social experiences can be a process of discovery and wonder and would perhaps be a good way to survive in the world with confusing nutrition messages. Constructivist Theory is based on the following principles (Bodner, 1986, Ackermann, 2015)

- The learner creates his or her knowledge and beliefs
- Learners inspired by personal experiences to create meaning
- Learning activities should lead learners to connect with their experiences, knowledge and beliefs
- Learning is a social activity that is multiplied by sharing experiences and reflecting on ideas and concepts to understand & construct personal knowledge
- Learners play a pivotal role in assessing their own learning; the outcomes of the learning process are varied and often unpredictable

Integrating the Constructivist Theory principles for creating a learner-focused NEI suggests that a dynamic classroom may be consumer-centric. Once the basic concepts are shared, the learners can

help leading and assessing their own learning. Learners on sharing their individual knowledge and experiences can evolve complex solutions together than they perhaps could have as individuals.

Objective: To develop and evaluate the effect of a theory-based nutrition education intervention on the comprehension of nutrition messages on Food labels and the behaviour of adult graduate consumers in Mumbai.

Rationale: The consumer-centric curriculum, created is based on the Constructivist Theory. It supports a conducive classroom environment especially for learners from non-nutrition, non-technical background. The activity-based process may nudge the learners to look for relevant nutrition messages on food labels and process them to make an informed decision. An ideal curriculum should empower the learners to relate to and comprehend the messages at multiple levels as a whole rather than just looking at select modes especially Health and nutrition claims on the FOP. This NEI will be both helpful and useful to other nutrition educators to develop skills to use nutrition messages on food labels effectively. Ultimately, this NEI is about the integration of a student's educational experience to make learning exciting, relevant, more meaningful and memorable, and fun. Today's classroom needs empowered students who are engaged in their learning and evaluation to be successful.

MATERIALS AND METHODS

The nutrition education intervention (NEI) was designed under the guidance of an expert from the field of education. It was decided to develop a non-credit course so that it offered more flexibility in terms of current and future use to educate adult consumers. The experimental design consisted of a single group; pre-post scores were assessed with the incorporation of the NEI as treatment. A convenience sample of 46 female students enrolled in a post-graduate course from a college affiliated to the S.N.D.T Women's based in Mumbai were recruited after obtaining informed consent from the participants and also the authorities in charge.

The Inclusion criteria were:

- Young Adults (21-25 years)
- Minimum qualification of graduation
- No formal qualification/training/work experience in nutrition/ health and fitness sector

The Nutrition education intervention was designed through the following steps:

Step 1: The gaps in the knowledge base and procedural skills required to optimally utilize the nutrition messages on food labels for the selection of health-promoting foods were found by a survey on 1212 consumers and Focus group discussions on 4 groups of consumers. The findings of other similar studies conducted in India were also considered.

Step 2: Development of the Content based on the gaps reported by the consumers as their experiences during the use of nutrition messages on food labels. During the development of the units, we incorporated a measuring and tasting component to provide an opportunity to choose appropriate portions as a hands-on activity in a unit.. The hands-on experience supports the learner-centred activity that helps engage learners into a more memorable experience resulting in a behaviour change that can be possibly be practised in real life.

Step 3: The validation of the content by Experts, which include Practising Professionals from the field of nutrition and representatives of Consumer Interest NGO's and Ex-members of the FSSAI sub-committee for Food labelling. Few minor suggestions by experts were incorporated into the content.

Step 4: Development of the detailed lesson-plans with specific objectives based on Bloom's revised taxonomy (A tool to design a logical framework based on learning objectives):

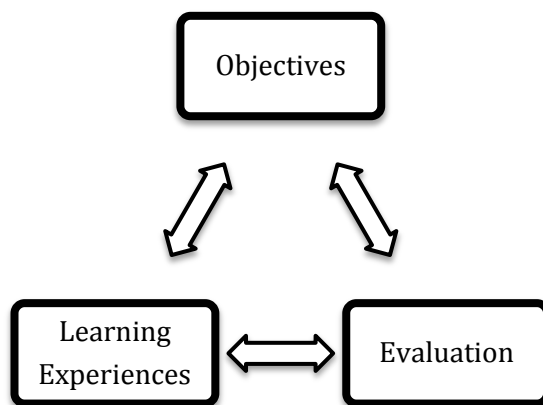


Figure 1: Triangle of Evaluation

Figure 1 depicts the crux of the intervention was the triangle of evaluation, which deals with continuous inter-relationship between educational objectives, the learning experiences and evaluation. This is discussed in detail below.

Learning Objectives: Learning objectives/outcomes are the crux of a good lesson plan. Ideally, they specify observable, measurable changes in a learner's behaviour at the end of the learning. Anderson and Krathwohl (2001) developed the revised Bloom's taxonomy for teaching, learning and assessing. The salient feature of this revised taxonomy is that it integrates perspectives from three unique areas. These are cognitive psychologists, curriculum experts along with teacher educators and assessment experts. So a seamless flow for effective learning can be followed for the curriculum of various areas. In this case, a Consumer education initiative in the form of a NEI was developed with specific objectives to nudge consumers towards making science-based choices of RTE foods. The detailed blueprint with the learning objectives and evaluation are presented later in this document.

Step 5: Development of the Learning Experiences

The ADDIE model of Instructional design was used to build the learning experiences. The term ADDIE, according to Molenda, (2003) “is merely a colloquial term used to describe a systematic approach to instructional development, virtually synonymous with instructional systems development (ISD).”

Application of the ADDIE Model of Instruction Design to develop and evaluate the NEI:

1. Analysis

Need Analysis:

Food choices have become more complex since processed foods have varied compositions as compared to simple homemade snacks or natural foods. Understanding the food choices by reading food labels can help us in making healthy choices and thereby leading a better lifestyle.

Learner analysis: The students are

- Girl students
- Young Adults (21-25 years)-because they are categorised as early majority adaptors based on the diffusion of innovation theory
- The learners are graduates (Not studied nutrition formally and/or from the health & fitness sector)
- From low to middle-income background with limited access to computer and internet facilities at home

Content Analysis/ Task Analysis:

- Conceptual Knowledge: Importance of Food Label, Parts of Food Label, Terms on a food Label
- Use of Ingredient list, use of nutrition label, use of claims
- Procedural Knowledge: Comparing products, making healthy choices

Context analysis:

- A room with facilities for using multi-media for 40 students,
- Space for interactive activities for about 40 students

Delivery of learning objectives:

- Face-face with live demonstrations, videos, worksheets, discussions, activities which are a joyful experience with scope for logical, reflective and creative thinking

Time frame to complete the goal: 15 hours of interaction

Instructional Goal:

- The learner is able to access, interpret and use nutrition messages on food labels to choose ready-to-eat foods for a healthy lifestyle.

Instructional Analysis: (Steps)

- i. The learner locates the nutrition messages on food labels.
- ii. Segregates the reliable nutrition messages from the rest of the information on food labels.
- iii. Converts the messages (numeric and non-numeric) for practical use based on their health goals
- iv. Compares and contrasts the messages on similar products
- v. Chooses the appropriate product/s

Learning Objectives:

An overview of the learning objectives is stated below. The learner is able to:

- i. Remember
 - Describe the content-health relationship
 - Label the different parts of a food label which communicate nutrition messages
 - Recognise the content which will enable them in making healthy choices
- ii. Recall
 - Explain the & diet-disease association especially regarding high fat, sugar and salt content
 - Classify products which can be eaten regularly and occasionally
- iii. Apply
 - Infer the process of using food labels for meeting health goals
 - Execute the use of food labels to make healthy choices
- iv. Evaluate
 - Predict the effects of consuming the chosen food product
 - Justify the choice made

2. Design

The structure of the course was aligned with the learning objectives. The content and learning strategies were based on previous research. The information was analysed and the prototype was created was reviewed and validated by experts.

3. Development

Worksheets, case studies, activity-based games and a power-point presentation were designed in accordance with the learning objectives for each unit of the lesson plan. A pilot test was conducted on 5 learners from similar demographics of those from the target group. Minor revisions were needed like the use of a mix of languages-English and Hindi for better receptivity of the content and effective communication.

4. Implementation

The detailed lesson plans developed for the NEI the content, methods and procedures were administered to the learners after official consent from the College administrators and facilitators. The 15 hours of interaction were conducted either in the seminar room with audio-visual facilities or the food science laboratory.

5. Evaluation

There were formative evaluations in the form of worksheets based on the content were conducted for select sections of the lessons. A variety in evaluation formats allows students to hold a deeper understanding of the content. It included the selected-response type or objective type, consisting of a few high order thinking multiple-choice tests. The NEI evaluation includes a process-focused assessment, based on observation and discussion. It is expected that value addition may occur if the evaluation process enthuses the learners in applying the knowledge and skills obtained through the lessons to the real-life scenarios. Learners were assessed not only by the expert but also their peers. The learning objectives of the lessons were demonstrated as performance-focused assessment and process-focused assessment by identifying and justifying choices of health-promoting foods in different real-life scenarios. Summative evaluation was conducted to receive feedback from the learners after the process of knowledge transfer was duly completed. The NEI was well received by the learners.

Step 6: Conducting the Pre & Post Evaluation test on the Target group:

A parallel pre-test and post-test that was developed were based on the blueprint, which was designed earlier in the process. It was validated by experts from the field of education, nutrition, representatives of consumer interest group and ex-members of the scientific committee of FSSAI. The same was administered pre and post NEI. The objective was to assess the effect of the NEI on the comprehension of nutrition messages on food labels and its effect on the behaviour of the target group. The tests consisted of 20 objective types multiple choice questions with maximum scores of 30. The maximum duration of the test was 30 minutes.

Table 1: Blueprint developed for the NEI Objectives

Unit	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total
1. The implications of food choices on our health and life	2						2
2 The relevance of use of food labels to comprehend the nutrition messages on food labels	2						2
3. The major components of a food label (FOP)	1	1					2
4.The components, which assist in judging the healthfulness of the food		1			1		2
5.1 The terms related to nutrition on food labels:	1			1			2
5.2 Concepts of Energy				1	1		2
5.3 Concept of Carbohydrates		2					2
5.4 Concept of oils and fats		1		1			2
5.5 Salt and sodium in food	1	1					2
6. Uses of nutrition messages to achieve health goals during purchase and/consumption:			3		3		6
7. Choice of Healthy Options Consciously Every time (CHOICE)	3		3				6
GRAND TOTAL							30

The NEI outline has been elaborated in Table 1 which consists of an over view of the curriculum, which has been divided into study units for the ease of implementation. The evaluation scores for each unit have been split into the corresponding learning objectives for each unit. This ensures that the learning objectives are evaluated in the parallel pre and post-tests designed to assess the effect of the NEI.

RESULTS AND DISCUSSION

The attendance was marked for learners for the number of hours attended out of 15. The scores of select 30 students out of a total of 46 students were analysed since they had over 80% attendance. A traditional statistical evaluation was used to assess the current behaviour and to measure the changes in behaviour regarding with regard to comprehension of nutrition messages on food labels.

Table 2: Results of Pre-test and Post-test Scores

Condition	Pre- NEI	Post- NEI	p value
Mean Score	12.07	20.50	0.00*
± SD	2.51	4.49	

Note: Intra group comparison was made by paired t-test* p significant at ≤ 0.05

Table 2 depicts the mean scores obtained by 30 participants in the face-face intervention. The results were evaluated using the Microsoft Excel for Mac 2011 version 14.0.0(100825). When the pre and posttest scores were evaluated by paired t-test, the p-value was obtained was 0.00 ($p \leq 0.05$). This confirms a statistically significant difference between the pre-test and posttest scores of the group. These results do imply that the NEI had a positive effect on the comprehension of nutrition messages on food labels. These findings are in alignment with similar studies conducted in other parts of India. Subbarao et al (2016) have found significant differences between the pre-intervention and post-intervention scores of adolescent learners when the Multi-component communication Read-B-4-U-Eat module was administered. Shah et al (2010) have similarly reported improvement in nutrition knowledge in urban Asian Indian school children.

CONCLUSION

The developed NEI is a theory-based model that integrates curriculum, with a contemporary assessment that will involve student participation in the evaluation and documentation. Creating a contemporary, dynamic model will realign existing resources to produce an exciting place to learn and a rewarding place to teach. The findings of the study revealed that the theory based curriculum to assist consumers to comprehend nutrition messages on food labels worked well. It may complement and enhance the life skills of adult learners from a non-nutrition background. This NEI can be replicated to enhance the consumers' comprehension of nutrition messages on food labels. Furthermore, this curriculum may be useful in that it will provide a guideline for other consumer education initiatives. Ultimately, this NEI is about the integration of a NEI to make learning exciting, relevant, more meaningful and memorable, and fun. Today's world needs empowered consumers who are capable of choosing health-promoting foods to be fit & healthy. This NEI is based on a model that integrates curriculum with recommendations of the health authorities for a healthful life. This contemporary, dynamic model may realign existing resources to produce an exciting environment to learn and a rewarding place to teach in the area of nutrition education for consumers. The implications

of this NEI may be far-reaching. Learners may share their learning with their friends and families to use nutrition messages on food labels. Students may use the knowledge at the point of purchase and simple tips may assist them to make health-promoting choices consciously at all times. These changes may lead to long-term effects on improving eating patterns and may snowball into fewer health-related costs to the families, health care industries and government agencies.

LIMITATIONS AND RECOMMENDATIONS

The NEI is developed for Graduate consumers from the City of Mumbai. The same may not be applicable for other categories of at-risk consumers with lower literacy and numeracy. The effect of the NEI of selection of health-promoting foods in real life needs to be investigated further.

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REACTIVE DYEING ON COTTON USING CONVENTIONAL PROCESSES AND SUPER CRITICAL CARBON DIOXIDE

Dr. Vishaka Karnad¹ & Nishrin Doriwala²

Waterless methods for coloring fabrics are feasible for polyester; however natural fibres using similar processes are damaging. Cotton comprises 45% of the global textile industry sector that uses large quantities of water for coloration and processing. Review of literature shows prospects for SFC dyeing on synthetic fibres using disperse dyes. The study explored possibilities of optimizing reactive dyeing process for cotton using supercritical carbon dioxide and attempted to establish alternative methods to conventional dyeing reducing water and electrolyte for cotton reactive dyeing. Cotton fabric was dyed with three dyeing techniques of Exhaust, Pad-dry and Supercritical Fluid Carbon-dioxide (SFC) with Reactive Orange 131 and 72 for 4% shades. Considering performance of samples dyed using exhaust dyeing (with salt and no salt) and using MLR of 1:10 and 1:20, pad-dry and Supercritical Fluid Carbon dioxide dyeing, it was observed that conventional technique of exhaust dyeing produced optimum results followed by pad-dry, methanol soaking and SFC. On evaluation of fastness and physical properties exhaust dyed samples had better fastness in comparison to other dyeing techniques excepting light fastness wherein SFC dyed samples showed better results. Considering physical properties, methanol and SFC dyed samples showed better fastness than Exhaust and Pad-dry techniques. An increase in tear strength was observed in methanol and SFC dyed samples. A reduction in tensile strength across all samples and dyeing techniques was observed and comparatively lesser reduction in tensile strength was observed in methanol soaked and SFC dyed samples.

Keywords: Cotton, Reactive Dyeing, Exhaustion, Pad-dry, Supercritical Carbon-Dioxide Dyeing

INTRODUCTION

The textile industry is considered as one of the most ecologically hazardous industry in the world, polluting the environment with production and processing that involves chemical intensive applications. The eco-impact of the textile industry is carried from raw material to production processes and right forward to the finished product. The major environmental factors associated with the making of textiles include water and energy. The textile industry leaves one of the largest water footprints on the planet being water intensive. The challenge is to adopt more water-friendly technologies for various wet processing. Waterless dyeing is becoming the textile industry's thrust area for research. Widespread adoption of this technology is a need. Sabat and Magdum, (2012) explain

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that there is a demand for novel colouration technologies like waterless dyeing and recycling dyeing baths with the aim to make textile processing and colouration eco-friendly.

Use of supercritical fluid is a German technology invented around 25 years ago. Substances at a temperature and pressure above its critical point where distinct liquid and gas phases do not exist can be termed as supercritical fluids. Gases such as xenon, ethane and carbon dioxide can be used as supercritical fluids. Carbon-dioxide is a readily available, cheap, recyclable, non-toxic and non-flammable. Carbon dioxide above the critical point i.e. above 74 P (bar) and 31°C exhibits properties of a liquid and a gas with liquid-like densities and gas-like low viscosities and diffusion properties acting as a supercritical fluid. This facilitates dye dispersion and shortens dyeing cycles as well. Figure 1 explains the temperature and pressure condition for supercritical fluid carbon-dioxide. Figure 2 explains the layout of a typical SFC dyeing equipment.

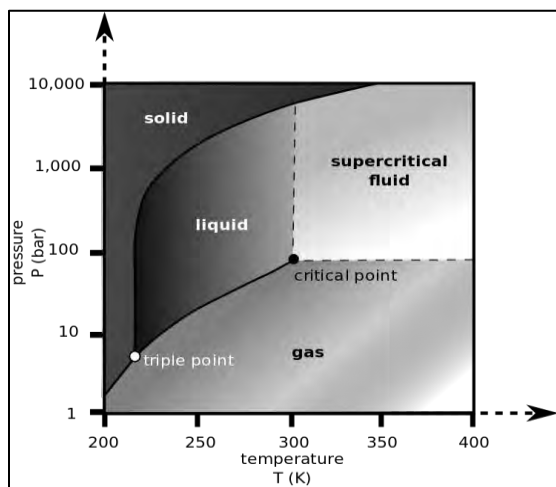


Fig. 1: The temperature and pressure condition for supercritical fluid carbon-dioxide.

Source:

[http://en.wikipedia.org/wiki/Supercritical carbon dioxide](http://en.wikipedia.org/wiki/Supercritical_carbon_dioxide)

C: Dyeing Autoclave, S- Separator, D1- Water tank, D2- Dye vessel, P1-pressurization Pump, P2- Circulation Pump, E- Heat Exchanger, F-Filter

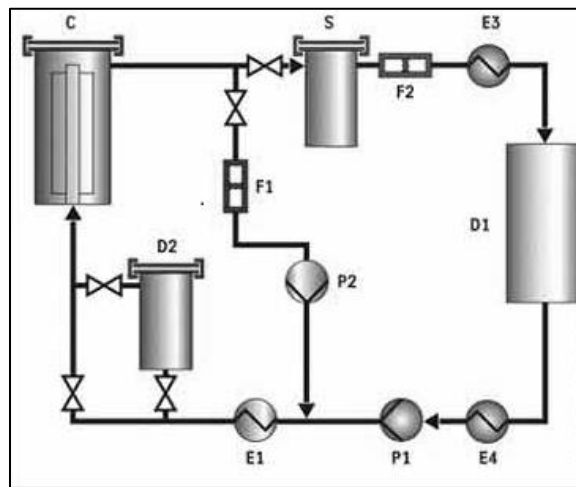


Fig. 2: SFC dyeing equipment.

Source:

http://www.geocities.ws/dyes_pigments/new-dyeing-concepts.html

Thus to eliminate disadvantages of conventional dyeing, supercritical fluids are employed like carbon-dioxide. The dyeing time is reduced considerably as compared to the conventional dyeing process, although dyeing with supercritical CO₂ is still in its infancy and a large amount of research input is needed for integration into the conventional system. Dyeing with this technique has been found to be successful with synthetic as well as natural fibres providing better dye penetration and fastness to the textile products.

Several types of research have been done to explore this alternative technique of dyeing textile fibres. Different solvents have been used and process conditions of time and pressure on various fibres have been experimented by researchers Van der Kraana, Bayraka, Fernandez, et al. 2014. Methanol is found to be the best solvent for the pre-treatment and dimethylsulphoxide (DMSO) as co-solvent along with a dye carrier but with a fixation of only 2%. Supercritical carbon-dioxide dyeing by disperse dyes on modified cotton with low-temperature plasma and polybasic carboxylic acid gives better results. The dyeing process primarily influences dyeing results. The parameters for optimum dyeing are 24 MPa pressure and 100°C temperature. Gangopadhyay, Rekha & Shinde (2012) are of the opinion that supercritical and near-critical carbon dioxide in green chemical synthesis and processing is becoming popular. Careful application of CO₂ technology can result in products (and processes) that are cleaner, less expensive and of higher quality. There is immense potential in supercritical carbon dioxide fluid and good scope for being adopted by the industry.

EXPERIMENTAL MATERIAL AND METHOD

The study involved the use of cotton fabric (RFD, yarn count= 21^s warp and 22^s weft, fabric count = 93 EPI x 63 PPI) and reactive dyes (Dye 1- reactive orange 72 and Dye 2- reactive orange 131) using three dyeing methods, namely Exhaust dyeing, Pad-dry Dyeing and Supercritical Carbon-dioxide dyeing (SFC). The samples were dyed at MLR 1:20 and 1:10 using salt and no salt.

Experimental Conditions

Table 1: Parameters for dyeing

Parameters	Exhaust dyeing	Pad-dry dyeing	Supercritical carbon dioxide
Glauber's salt	80 g/L No salt	80 g/L No salt	--
Dye (reactive)	4 %	4 %	4 %
Soda ash	2 g/L	2 g/L	--
M: L	1:10 and 1:20	1:10	1:10 (Methanol)
Concentration of dye	0.5%	0.5%	
Time	60 min	45 min	3 ½ hours
Temperature	60°-100°C	60°-100°C	75°-80°C
Pressure		25 bars	250 bar with Flow rate of CO ₂ 0.8 kg/hr.

Assessment of Samples

The undyed and dyed sample were assessed on basis of the physical test, namely tear strength (ISO 13937 PART-1: 2000), tensile strength (ISO 13934 PART-1) and abrasion resistance (ISO 12947 PART-2:1998). The dyed samples were assessed on the basis of color-fastness tests, namely color fastness to rubbing (ISO 105-X12), color-fastness to perspiration (ISO 105-E04), color-fastness to washing (ISO 105-C02) and color-fastness to light (IS 2425:1985)

RESULTS AND DISCUSSION

The evaluation of the dyed and undyed samples was carried out on basis of color-fastness properties and physical properties.

Comparison of dyeing techniques on basis of color fastness to washing, rubbing and light

Samples showed fairly good to good results to **wash fastness** tests, with exception of Methanol and SFC that showed extremely poor fastness for staining in warp and weft direction. Exhaust dyed fabric showed moderate to good fastness to staining and color change. Pad Dry dyed samples showed fairly moderate to good fastness for color change and staining. SFC dyed fabric showed very poor fastness for color change and staining. This indicates that exhaust dyeing produced optimum results with respect to **acidic and alkaline perspiration fastness**. Exhaust dyed fabric showed good to very good fastness for **dry rubbing and wet rubbing**. In pad-dry dyed fabrics, wet rubbing reduced to fairly good. It may be noted that SFC dyed fabrics showed very poor fastness for wet rubbing in comparison to dry rubbing that was fairly good inferring that SFC dyeing technique methanol reduced wet rubbing fastness. On comparing **light fastness properties**, across all samples dyed with the three methods, SFC dyed fabrics showed optimum results followed by methanol dyed, exhaust dyed fabric and pad dry dyed fabric.

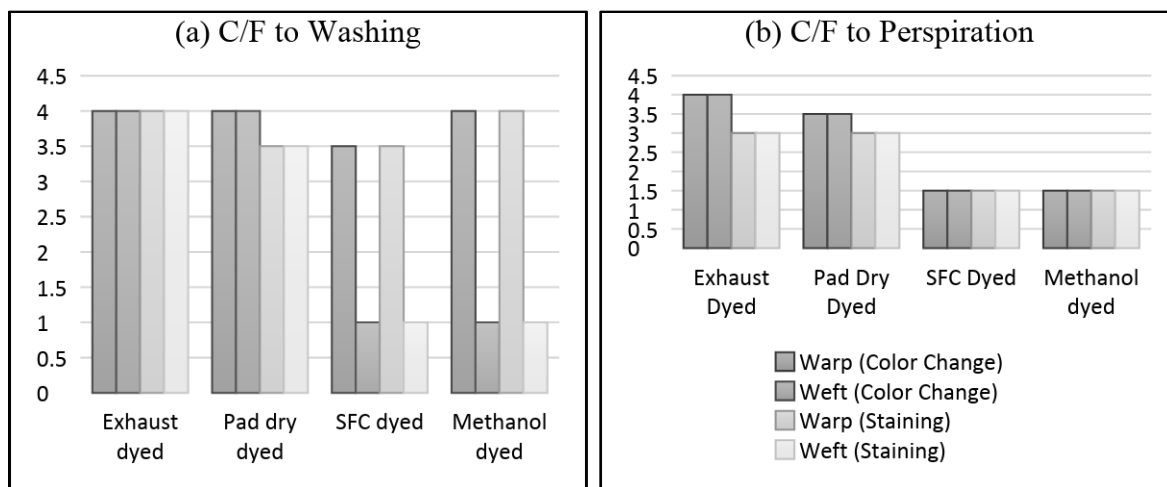


Fig. 3: Comparison of dyeing techniques on basis of color fastness: (a) washing (b) perspiration

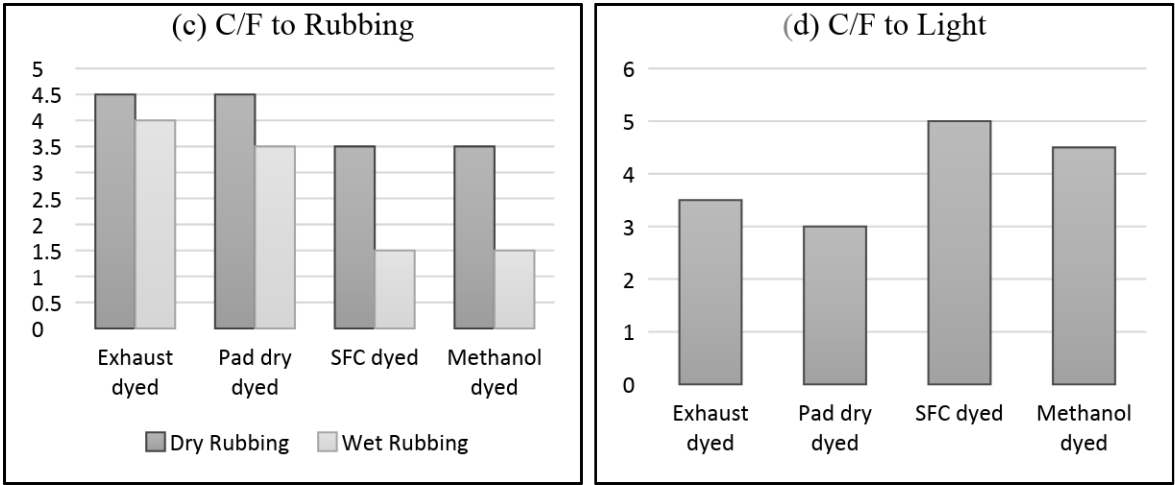


Fig. 3: Comparison of dyeing techniques on basis of color fastness: (c) rubbing and (d) light

Comparison of dyeing techniques on the basis of tensile strength

As depicted in the Figure 4. SFC dyed fabric showed best result followed by pad dry dyed and exhaust dyed in warp direction whereas in weft direction best result was seen in pad dry dyed fabric followed by SFC dyed fabric and exhaust dyed fabric. Reduction in the strength was observed by 12% in warp direction and 18% in weft direction.

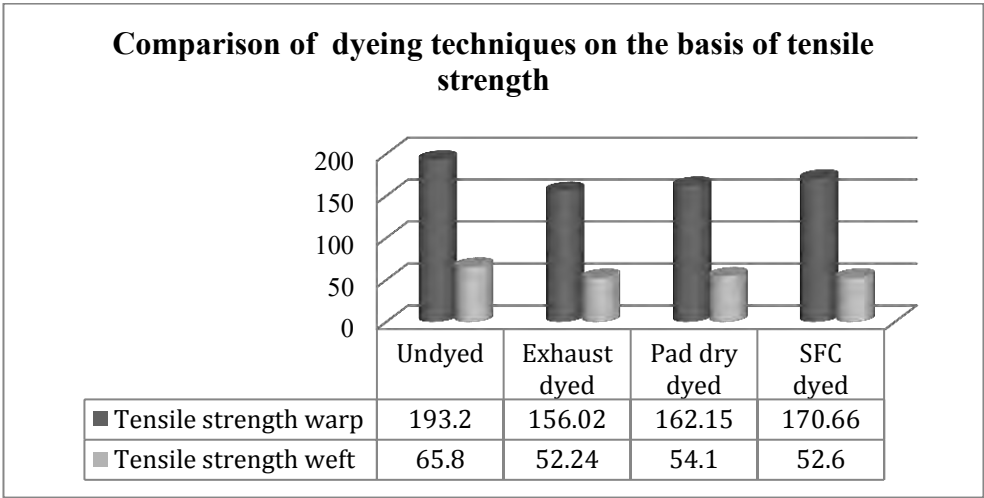


Fig. 4: Comparison of dyeing techniques on the basis tensile strength

Comparison of dyeing techniques on the basis of tear strength

As depicted in Figure 5 optimum results were seen in exhaust dyed fabric followed by SFC dyed fabric and pad dry dyed fabric in warp direction whereas in weft direction best results were observed in SFC dyed fabric followed by exhaust dyed fabric and pad dry dyed fabric.

Pad dry dyed fabric showed reduced strength due to the continuous movement of fabric in padding mangle that stretches the fabric continuously during dyeing.

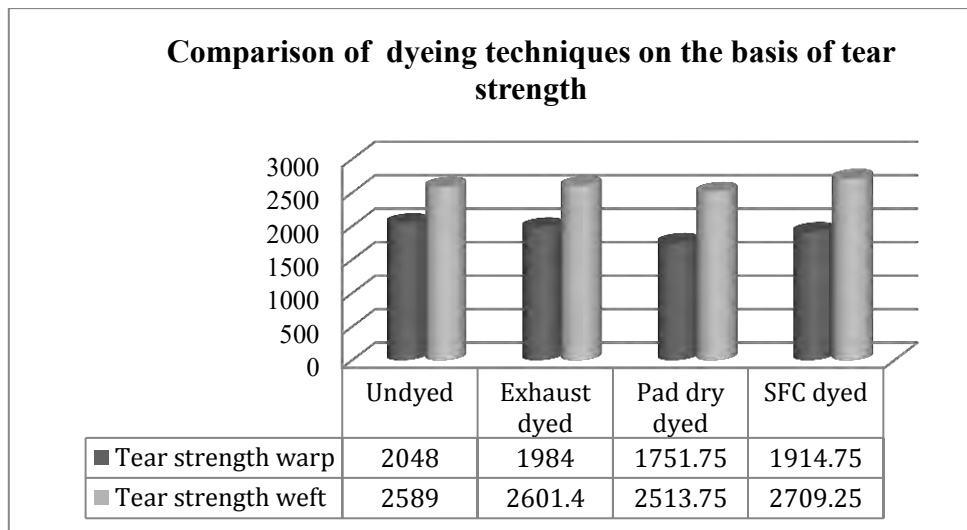


Fig. 5: Comparison of dyeing techniques on the basis tear strength

CONCLUSION

- The fabric was identified as cotton by using burning, microscopic and solubility tests. The cotton fabric had a yarn count of 21^s and 22^s in warp and weft direction and fabric count of 93 EPI × 63 PPI.
- For color fastness to rubbing, exhaust dyed samples showed very good to good fastness towards dry and wet rubbing followed by pad dry dyed and SFC dyed samples.
- For color-fastness to perspiration, exhaust dyed samples showed good fastness towards color change and staining in alkaline and acidic conditions followed by pad dry dyed and SFC dyed.
- For color-fastness to washing, exhaust dyed samples showed good fastness for color change and staining in warp and weft direction followed by pad dry dyed samples with good and fairly good fastness for color change and staining respectively.
- For color fastness to light, SFC dyed samples showed excellent fastness to light followed by exhaust dyed and pad dry dyed samples.
- Amongst physical properties of tensile strength and tear strength, SFC dyed samples showed least decrease in tensile strength followed by pad dry dyed samples and exhaust dyed sample and there was an increase in tear strength observed in the SFC dyed and exhaust dyed samples while pad-dry dyed samples showed a decrease in the tear strength respectively.
- All the samples un-dyed and dyed with three different techniques showed excellent resistance even after 3000 rub cycles indicating that neither the dye nor the dyeing technique affected the abrasion resistance.

Water scarcity is the most important sustainability issue that the textile industry is facing due to the dependency of industry on water for the process of dyeing and finishing of fabric. A lot of progress could be made by managing and adopting best practices. Hence there is substantial research undertaken by research bodies for optimized use of water without and reducing the amount of water usage in the industry. As per the review of literature, one good option is the use of supercritical fluid especially carbon dioxide for the process of dyeing as it uses no water in its process and can be easily conserved and reused. It is proved to have compatibility with synthetic fibres using disperse dyes and a few research findings show effective results with select natural fibres using reactive disperse dyes. By employing this technique a lot of water could be conserved that could be easily used elsewhere. Water pollution caused by the textile sector would be drastically minimized thereby contributing to the environment for its better and longer sustainability using modern technologies.

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PERCEPTION AND PREVALENCE OF DEPRESSION AMONG LATE ADOLESCENTS (14 YEARS – 17 YEARS) AND EARLY ADULTS (18 YEARS – 25 YEARS) MALES AND FEMALES

**Dr. Kamini Rege¹, Sneha Gala², Vinaya Dasgaonkar³,
Zahabia Jaliwala⁴ & Nupur Upadhyay⁵**

Depression is a medical illness that negatively affects one feels, the way one thinks and how one acts. Objectives were: to assess the prevalence of depression among late adolescents (14–17 years) and early adults (18–35 years); and to design a brochure for creating awareness regarding depression. Sample size consisted of 120 participants, [60 were late adolescents (30 males and 30 females) and 60 were early adults (30 males and 30 females)] were selected using snowball sampling method. Most of the participants belonged to nuclear family (57%); Hindu (41%) and few Muslim (29%). Minimum educational qualification was Higher Secondary Certificate (45%). Semi-structured tool included 5 open-ended questions and Beck's Depression Inventory Test. The result revealed that early adult males scored higher (13.26) than the early adult females who scored 11.03 according to the Beck Depression Inventory. Among late adolescent females the score was found to be much higher (16.5) than the late adolescent males (9.03). According to the Beck Depression Inventory interpretation scale, all late adolescent participants (12.76) and all early adult participants (12.15) were included under the category of having mild mood disturbances. The late adolescent males (9.03) fell under the category of having ups and downs which are considered normal; whereas late adolescent females (16.5) were under the category of borderline clinical depression. The late adolescent males (9.03) score lower compared to early adult males (13.26), thus falling under the category of mild mood disturbances. Depression in adolescents is a major risk factor for suicide, leading cause of death in this age group. Some ways to deal with depression include lifestyle changes, like sticking to a balanced diet, sleeping well, thinking positively, and above all seeing a therapist immediately when in a downward spiral (Fletcher, 2008).

Key words: Depression, Early and Late adolescents, Awareness regarding depression

INTRODUCTION

But there's one thing for sure: "It is much more than just a sad mood," said Angelos Halaris, MD, a professor of psychiatry and medical director of adult psychiatry at the Loyola University Medical Center in Chicago. Unipolar depressive disorder is a common mental health problem in adolescents worldwide, (Murray, 2006) with an estimated 1-year prevalence of 4-5 % in mid to late adolescence. (Angold, 2006) Depression also leads to serious social and educational impairments, (Fletcher, 2008) and an increased rate of smoking, substance misuse some respects depression in adolescents can be viewed as an early-onset sub-form of the equivalent adult.

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Depression in adolescents is a major risk factor for suicide, the second-to-third leading cause of death in this age group, (Hunt, et al. 2008) with more than half of adolescent suicide victims reported having a depressive disorder at the time of death. The word depression is just an umbrella term for a number of different forms. Depression is a worldwide problem not even in India but also in all over foreign countries.

Depression is a leading contributor to the global burden of disease. The incidence and prevalence of depression increase rapidly from childhood to early adulthood, and by age 18 years the prevalence is similar to that in adults.

Depression is a disorder of major public health importance, in terms of its prevalence and the suffering, dysfunction, morbidity, and economic burden. Depression is more common in women than men. The report on Global Burden of Disease estimates the point prevalence of unipolar depressive episodes to be 1.9% for men and 3.2% for women, and the one-year prevalence has been estimated to be 5.8% for men and 9.5% for women. It is estimated that by the year 2020 if current trends for demographic and epidemiological transition continue, the burden of depression will increase to 5.7% of the total burden of disease and it would be the second leading cause of disability-adjusted life years.

In view of the morbidity, depression as a disorder has always been a focus of attention of researchers in India. Various authors have tried to study its prevalence, psychosocial risk *factors* including life events, symptomatology in the cultural context, comorbidity, psycho-neurobiology, treatment, outcome, prevention, disability and burden.

(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3146226/>Retrieved on-11th July)

Concept of Depression

The word depression is just an umbrella term for a number of different forms, from major depression to atypical depression to dysthymia.

Depression: It causes feelings of sadness and/or a loss of interest in activities once enjoyed. It can lead to a variety of emotional and physical problems and can decrease a person's ability to function at work and at home. (For example, the deaths of a loved one, loss of a job or the ending of a relationship are difficult experiences for a person to endure. It is normal for feelings of sadness or grief to develop in response to such situations. Those experiencing loss often might describe themselves as being "depressed." But being sad is not the same as having depression. Depression is a major public health problem with high economic and societal costs. Depression was caused by low levels of neurotransmitters in the brain- chemicals like serotonin and norepinephrine. Severe depression requires both medication and therapy together. Alcohol; cigarette smoking and cannabis use are more significantly more common among late adolescents who are under depression. Out of whom only a small proportion of the adolescents experiencing depression have used professional help.

Depressive Disorder: Depressive disorders (unipolar depression) are mental illnesses characterized by a profound and persistent feeling of sadness or despair and/or a loss of interest in things that once

were pleasurable. Disturbance in sleep, appetite, and mental process are a common accompaniment. (<http://medicaldictionary.thefreedictionary.com/depressive+disorders>)

Beck Depression Inventory: The Beck Depression Inventory (BDI, BDI-1A, BDI-II), created by Aaron T. Beck, is a 21-question multiple-choice, self-report inventory that measures characteristics and attitudes of depression. It is one of the most widely used psychometric tests for measuring the severity of depression. (www.apa.org) Retrieved on- 10th July, 2017

Causes of Depression

The causes of depression are not fully understood, but scientists think that an imbalance in the brain's signaling chemicals may be responsible for the condition in many patients. However, there are several theories about what this imbalance actually is and which signaling chemicals are involved. Moreover, a variety of distressing life situations are also associated, including early childhood trauma, a job loss, the death of a loved one, financial troubles or a divorce. (<https://www.livescience.com/34718-depression-treatment-psychotherapy-anti-depressants.html>) The following causes for depression are given by Goldberg (May18, 2015)

Gender: Women are about twice as likely as men to become depressed. No one's sure why. The hormonal changes that women go through at different times of their lives may play a role. ([www.webmd.com › Depression › Reference](http://www.webmd.com/Depression/Reference))

Age: People who are elderly are at higher risk of depression. That can be compounded by other factors, such as living alone and having a lack of social support. (www.webmd.com)

Trauma and Grief: Trauma such as violence or physical or emotional abuse -- whether it's early in life or more recent -- can trigger depression in people who are biologically vulnerable to it. Grief after the death of a friend or loved one is a normal emotion, but like all forms of loss, it can sometimes lead to clinical depression. ([www.webmd.com › Depression › Reference](http://www.webmd.com/Depression/Reference)) Retrieved on- 23rd June, 2017; Meghan W (May 22, 2013):

Academic Stress: Stressing over classes, grades and tests can cause you to become depressed, especially if you're expected to excel at all costs or are beginning to struggle with your course load. (<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>)

Social Anxiety or Peer Pressure: During adolescence, you are learning how to navigate the complex and unsettling world of social interaction in new and complicated ways. Popularity is important to most teens, and a lack of it can be very upsetting. (<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>)

Romantic Problems: In adolescence, romantic entanglements become a much more prominent and influential part of life. From breakups to unrequited affection, there are plethoras of ways in which budding love lives can cause teens to become depressed. (<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>)

Traumatic Events: The death of a loved one, instances of abuse or other traumatic events can have a very real impact on anyone, causing them to become depressed or overly anxious.

(<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>)

Heredity: Some people are genetically predisposed to suffer from depression. If a parent or close relative has issues with depression, you may be suffering from a cruel trick of heredity that makes you more susceptible. (<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>)

Family Financial Struggles: You may not be a breadwinner in your household or responsible for balancing the budget, but that doesn't mean that you're unaffected by a precarious financial situation within the family. (<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>) Retrieved on- 23rd June, 2017

Symptoms of Depression

The general symptoms of depression can be: not going out anymore not getting things done at work/school withdrawing from close family and friends relying on alcohol and sedatives not doing usually enjoyable activities unable to concentrate. (<https://www.beyondblue.org.au/the-facts/depression/signs-and-symptoms>)

Depression can take many forms and has varying levels of severity. Part of the variability in the disorder happens because it can co-occur with many other mental disorders (such as anxiety disorders or substance use disorders), which shape the manifestation of depression. (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>) Symptoms are as follows:

Loss of interest or pleasure in most or all activities – People with depression are no longer as interested in or feel as much pleasure doing the things they used to enjoy. The medical term for this is anhedonia. Hobbies and activities lose their appeal, and depressed people say “they don't care anymore.” They may withdraw from or lose interest in friends, and they may even lose interest in sex. (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>)

Change in appetite or weight – Appetite and weight can either decrease or increase as part of depression. Some people have to force themselves to eat, while others eat more and sometimes crave specific foods (such as junk food and carbohydrates). (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>)

Insomnia or hypersomnia (sleeping too little or too much) – Depression often disrupts sleep patterns; leading people to either sleep too much or be unable to fall asleep or stay asleep. Even when they do sleep, people with depression often say that they do not feel rested and have a hard time getting out of bed in the morning. (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>)

Feelings of worthlessness or excessive guilt – People with depression can feel inadequate, inferior, worthless, or like a failure. They often carry tremendous guilt about this. Often this leads them to misinterpret neutral events or minor setbacks as evidence of personal failings. (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>)

Poor concentration – Some people with depression have trouble thinking clearly, concentrating, or making decisions. They can also be easily distracted or complain of memory problems. (<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>)

Recurrent thoughts of death or suicide – individuals who are depressed can experience recurrent thoughts of death or suicide, and may attempt suicide. Thoughts of death or suicide, termed “suicidal ideation,” can be passive, meaning the person thinks simply that life is not worth living, but they can also be active, meaning the person actively wants to die or commit suicide. People with active suicidal ideation are severely ill.

(<https://www.mind.org.uk/information-support/types-of.../depression/symptoms>) Retrieved on- 28th June, 2017

Assessment Tools

Beck Depression Inventory (BDI) - The Beck Depression Inventory (BDI) is a 21-item, self-report rating inventory that measures characteristic attitudes and symptoms of depression (Beck, et al., 1961). The BDI has been developed in different forms, including several computerized forms, a card form (May, Urquhart, Tarran, 1969, cited in Groth-Marnat, 1990), the 13-item short form and the more recent BDI-11 by Beck, Steer & Brown, 1996. (See Steer, Rissmiller & Beck, 2000 for information on the clinical utility of the BDI-11.) The BDI takes approximately 10 minutes to complete, although clients require a fifth – sixth grade reading level to adequately understand the questions (Groth-Marnat, 1990).

Internal consistency for the BDI ranges from .73 to .92 with a mean of .86. (Beck, Steer, & Garbin, 1988). Similar reliabilities have been found for the 13-item short form (Groth-Marnat, 1990). The BDI demonstrates high internal consistency, with alpha coefficients of .86 and .81 for psychiatric and non-psychiatric populations respectively (Beck et al., 1988).

BDI is a commonly used instrument for quantifying levels of depression. The scale for the BDI was originally created by patients’ descriptions of their symptoms – mood, pessimism, sense of failure, self-dissatisfaction, guilt, suicidal ideas, crying, irritability, social withdrawal, insomnia, fatigue, appetite, weight loss, self-accusation. In the first portion of the test, psychological symptoms are assessed whereas the second portion assesses physical symptoms. The BDI test includes a 21 item self-report using a four-point scale ranging which ranges from 0 (symptom not present) to 3 (symptom very intense). The test takes approximately 5 to 10 minutes to complete. There is a shortened version of the test consisting of 7 items intended to use by primary care providers. In a study conducted in Western Quebec, differences in the BDI scores were observed between female and male

adolescents, with females scoring significantly higher than males. However, none of the variables included in the questionnaire had a differential effect on the BDI scores of either male or female adolescents. (Pierre Baron and Lyse M. Perron, „Sex Differences in the Beck Depression Inventory Scores of Adolescents“, Journal of Youth and Adolescence, Vol. 15, August 15, 1985) After the American Psychiatric Association (APA) published the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV), the Beck Depression Inventory (BDI) was revised in 1996 to reflect changes to the diagnostic criteria for Major Depressive Disorder, becoming the BDI-II. The BDI-II also contains 21 questions, scored from 0 to 3. (www.statisticssolutions.com/beck-depression-inventory-bdi) Retrieved on- 11th July, 2017

Preventive Measures of Depression

As with all illnesses, depression prevention is better than cure. Whether it is depression onset for the first time or a relapse from depression, the same principle applies. Some important ways to fight off and deal with depression include lifestyle changes, like sticking to a balanced diet, sleeping well, thinking positively, keeping oneself occupied and engaged as much as possible, and above all seeing a therapist immediately when in a downward spiral. We discuss more about these preventive measures below. For people who have suffered from depression before, they will be able to notice if they are going down the same path again; it is not very difficult to recognize the signs and symptoms of depression during a relapse. Such people should immediately try and beat depression by ensuring the below basic lifestyle factors are well taken care of. This is important because with every passing hour, day, and week, the problem will worsen if one does not do anything to deal with it. Once out of control, the risk of depression onset or relapse becomes very high. (all-on-depression-help.com/depression-prevention.html) Retrieved on: 20th July, 2017

Rationale of the Study

Why depression?

Depression (major depressive disorder) is a common and serious medical illness that negatively affects how you feel, the way you think, and how you act. (www.psychiatry.org). Depression is a common mental health problem. The aim of this study is to make youth aware of the present scenario and suggestion possible guidelines. Depression also affects the health and well-being of an individual in every aspects-physically, mentally, socially, emotionally. Also, depression is seen in every individual mostly in those who are in late adolescence and early adults. Therefore, to make them aware of depression and level of depression the researchers chose this topic for the research.

Why perception of late adolescents and early adults?

Late adolescence is the period which ranges from 15 to 17 years. Depression is poor mental health can have important effects on the wider health and development of late adolescents and its association with several health and social outcomes such as higher alcohol, substance use, peer pressure, academic stress, romantic problems, family financial struggle and suicide.

(<https://mindyourmind.ca/expression/blog/10-things-may-cause-teenage-depression>).

Early adulthood is the period that ranges from 18 to 35 and this age is a time of great change for many people and has been associated with greater risk of mental health problems, higher levels of social stress, trauma and grief, suicide, a chemical imbalance due to the hormonal changes (www.dualdiagnosis.org). To know what late adolescents and early adults know about depression, the causes, symptoms, treatments of depression, if they recognize that they are in depression how can they handle it, control it and remedies for their problem of depression. A lack of appropriate knowledge can pose a bottleneck to early intervention. Also, limited mental health literacy impacts negatively not only to help seeking but also decision making on treatment, therefore, empowering vulnerable young to identify and seek help for possible mental help related problems can help in reduction of morbidity. (www.ncbi.nlm.nih.gov)

Objectives of the Study

Objective 1: To assess the prevalence of depression among late adolescents (14years-17years) and early adults (18years-35years) through Beck's Depression Inventory.

Objective 2: To compare the level of prevalence of depression through Beck's Depression Inventory among:

- a) Late Adolescent males and Late Adolescent females (14years-17years);
- b) Early Adult males and Early Adult females (18years-35years);

Objective 3: To design a brochure for creating awareness about depression.

METHODOLOGY

Research Design, Sample Size and Sampling Technique

The current study is exploratory research as it seeks to study unexplored area that is the perception of late adolescents and early adults towards depression. The total sample size consisted of 120 participants. Out of these 60 were late adolescents (30 males and 30 females) and 60 were early adults (30 males and 30 females). Snowball sampling and purposive sampling technique were employed.

Inclusion Criteria:

- Late adolescent (15-17years) males and females were included in the study.
- Early adult (18-35years) males and females were included in the study.
- No gender discrimination.
- Participants were not discriminated on the basis of community, religion, class, socio-economic status.
- Participants who lived in any type of family (nuclear, joint, extended etc.) were included.

Exclusion Criteria:

- Participants having any psychological disorder or other mental illness.

Sample Characteristics of the Participants

Researcher took two age groups for our research, late adolescents and early adults, where the age of the participants of late adolescents ranged between 14 years to 17years (60) and early adults ranged between 18 years to 25years (60). We had considered both males and females in our study, late adolescents male (30) and female (30) whereas early adult males (30) and females (30). Total half (60) of the participants were in the age range of 14-17 and one third (41) of the participants were between the range of 18-21. Majority of participants were students (99), whereas few of them were self-earning (25). Majority of participants were Hindu, late adolescents (22), early adults (23) and more than one fourth were Muslims late adolescents (15) early adults (20). With regard to the nature of family, half of participants were residing in nuclear family late adolescents (31) early adults (32) and quarter of them were residing in extended family late adolescents (15) early adults (18). Half of late adolescents were SSC students (34) and few in late adolescents were in HSC (14) and some early adults had HSC (34). Few in early adults (17) were also had graduated. Regarding family income per month of the participants, majority (12) of late adolescent fell into bracket of Rs.50,000 and above and early adults (18) fell into bracket of Rs.30,000 to Rs.40,000. (Refer to Table 1)

Table No 1: Sample characteristics of participants (n=120)

	Sample Characteristics	<i>f</i> (<i>n</i> = 120)	(%)
Age range	14-17	60	50
	18-21	41	34.16
	22-25	19	15.83
Occupation	Students	99	82.5
	Self-earning	25	20.83
Religion	Hindu	45	37.5
	Muslims	35	29.16
Family type	Nuclear	63	52.5
	Extended	33	27.5
Qualifications	SSC	34	28.3
	HSC	48	40
	Graduate	17	14.16
(Family Income)	Rs.50,000 and above	30	25
	Rs.30,000 to 40,000	18	15

Development of Tool

Pre-screening Pro-forma

The Pro-forma was prepared based on the inclusion as well as the exclusion criteria of the study. It was obtained with age of the late adolescents" males and females and early adults males and females, contact, address, religion, educational qualification, occupation, details of income, self-income, marital status, no. of children.

Questionnaire

The questionnaire consisted of close-ended questions. A structured questionnaire of Beck Depression Inventory was used. The Beck Depression Inventory was created by Aaron T. Beck, is a 21-question multiple-choice self-report inventory, one of the most widely used psychometric tests for measuring the severity of depression.

Step by Step Data Collection

The researchers visited libraries, retrieved literature from net and journals, selected the articles that were relevant to the topic. After collecting the articles the researcher submitted the articles to the research guide. A review of the literature was made referring to the articles, then the review was submitted to the guide. After receiving the feedback and corrections from the guide changes were made in the review of the literature. After submitting the corrected review, the researcher formulated the objective of the study. A semi-structured tool was made and submitted to the guide. This tool was pilot tested on 5 participants according to the inclusion criteria and who gave consent. There were no changes made. The sample size was 120, so each researcher had taken 30 forms and had to find out 30 participants. For the data collection the researcher had used the snowball technique, and purposive technique, this helped the researcher to get the participants easily. The researcher used a lot of method for collecting the data i.e. mail questionnaire, telephone questionnaire, in-house survey and self-administered questionnaire. After the data collection was over the forms were arranged according to their respective category i.e. late adolescent males and females, early adult males and females and numbered the forms accordingly. After which the researchers started with the evaluation process. After the evaluation was done, the researcher started with the resulting chapter.

Plan of analysis

Data was analyzed quantitatively. The plan of analysis was done for different objectives of the study. The responses of the late adolescent (males and females) and early adults (males and females) were quantitatively analyzed; qualitatively- totaled; percentages.

RESULT FOR THE STUDY

Objective 1: To assess the prevalence of depression among late adolescents (14 years-17 years) and early adults (18years-35 years) through Beck's Depression Inventory.

Result: According to, Beck's Depression Inventory Test, where the number of participants were early adults (n=60) and late adolescents (n=60). In which early adult's males (n=30) average score was higher which was 13.26 as compared to the early adult females (n=30) which was 11.03. Whereas in late adolescent's females (n=30) the score was much higher, which was 16.5 as compared to late adolescent's males (n=30) which was less in number 9.03. (Refer Table No. 2)

Table No.2: Overall scores of prevalence of depression among late adolescents (14 years-17 years) and early adults (18years-35 years) according to Beck's Depression Inventory

BECK DEPRESSION INVENTORY SCORES											
Late Adolescents[n=60] (Males [30]+Females [30])						Early Adults[n=60] (Males [30]+Females [30])					
Males n=30	Score	Females n=30	Score	Total n=60	Score	Males n=30	Score	Females n=30	Score	Total n=60	Score
271	9.03	495	16.5	766	12.76	398	13.26	331	11.03	729	12.15

Objective 2 (a): To compare the level of prevalence of depression through Beck's Depression Inventory among late adolescent male's v/s late adolescent females.

Result: According to Beck Depression Inventory interpretation scale, the late adolescent male participants [(n=30); (average score- 9.03)] fell under the category of having ups and downs that are considered normal. Whereas, the late adolescent female participants [(n=30); (average score- 16.5)] had borderline clinical depression. (Refer Table No. 3)

Table No. 3: Scores of prevalence of depression through Beck's Depression Inventory among late adolescent male's v/s late adolescent females

BECK DEPRESSION INVENTORY SCORES FOR LATE ADOLESCENTS [n=60]					
Males (n=30)	Score	Females (n=30)	Score	Total (n=60)	%
271	9.03	495	16.5	766	12.76

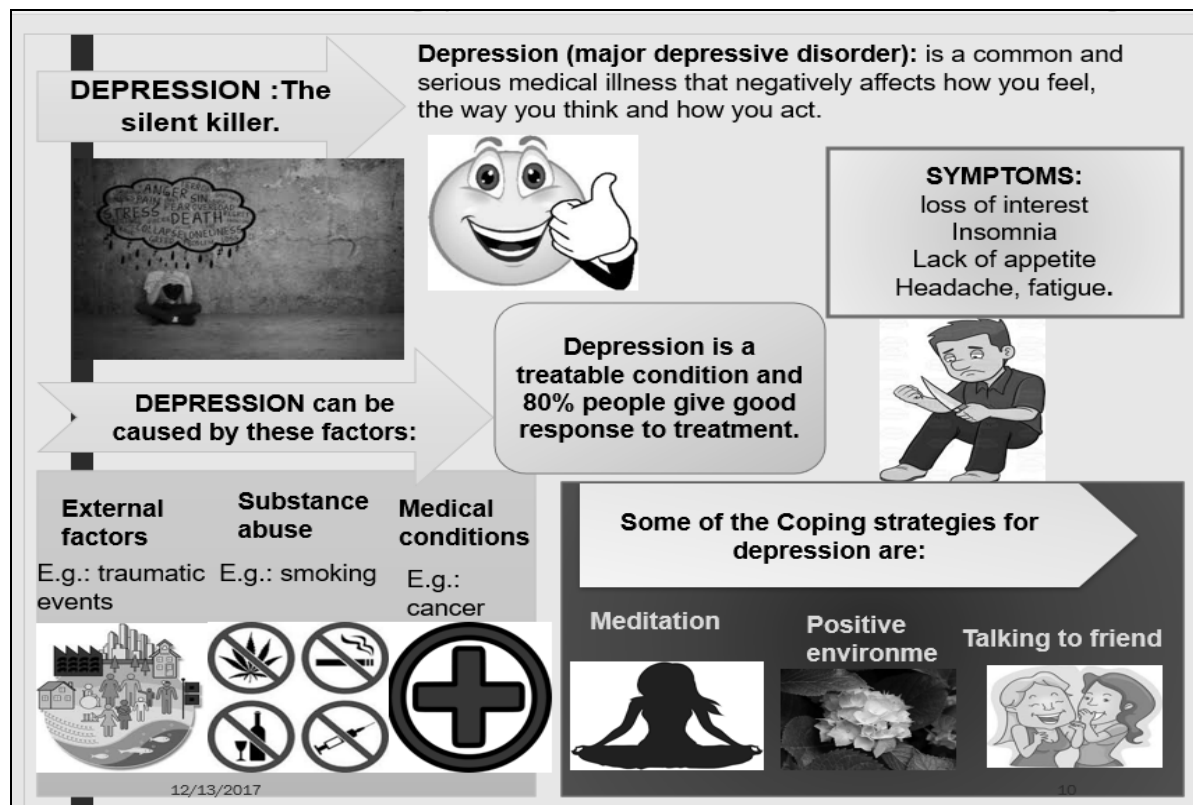
Objective 2 (b): To compare the level of prevalence of depression through Beck's Depression Inventory among early adult males' v/s early adult females.

Result: The early adult male participants (n=30) scored higher than (average score-13.26) and early adult female participants (n=30) who scored 11.03. Both early adult males and females fell under the category of mild mood disturbances according to Beck Depression Inventory interpretation scale. (Refer Table No. 4)

Table No. 4: Scores of prevalence of depression through Beck's Depression Inventory among early adult males' v/s early adult females

BECK DEPRESSION INVENTORY SCORES FOR LATE ADOLESCENTS [n=60]					
Males (n=30)	Score	Females (n=30)	Score	Total (n=60)	Score
398	13.26	331	11.03	729	12.15

Objective 3: To design a brochure for creating awareness about depression



DISCUSSION

About current research according to Beck Depression Inventory level of prevalence of depression in late adolescent females is highest, scoring 16.5 and falling under the category of borderline depression, which is similar to the review of literature which reveals late adolescent girls scoring significantly higher than males in a study conducted. (Pierre Baron and Lyse M. Perron, „Sex Differences in the Beck Depression Inventory Scores of Adolescents“, Journal of Youth and Adolescence, Vol. 15, August 15, 1985) The current study was conducted on the topic of "depression in early adults and late adolescent's males and females". While reviewing the literature, the wealth of information obtained has contributed substantially to the existing literature. Our research on depression has contributed information a lot about, the depression faced by late adolescents and early adults. The current research has developed a brochure to create awareness regarding depression. This brochure was developed on the recommendation of the experts, insights of the researcher and the suggestions proposed by the participants and review of the literature. Our research will also help other late adolescents and early adults, who were not part of our study to be aware of the symptoms and ways of coping or dealing with depression. Further development of pragmatic, cost-effective methods of detecting, assessing and treating adolescent depression in non-specialist contexts and low-income

and middle-income countries is an important priority in view of the scarcity of resources. The knowledge gap about relapse prevention is also noticeable. Finally, prevention strategies seem important because of the complexities and costs associated with the treatment of depression in adolescents. However, what the key components of these programs and policies ought to be is not yet clear. Cost-effectiveness must also be determined. Such strategies need to be a priority for future research. Several common themes run through these two. First, young people must learn and practice coping skills to get them through an immediate conflict or problem.

Coping strategies must emphasize self-responsibility to find positive, non-destructive ways to find relief. Second, communication skills are important. This involves being able to talk and selecting a good listener. It is important to express feelings, vent emotions, and talk about the problems and issues. Peers are good sympathizers, but it often takes an adult perspective to begin to plan how to make changes for the better. Third, young people need help to learn problem-solving skills. Sorting out the issues, setting goals and making plans to move forward are skills that can be taught and practiced. Ultimately, most young people will develop and assume the responsibility for their own protection and peace of mind. But during the years of learning and practice, parents, teachers and helping adults need to be aware of the signs and patterns that signal danger. Awareness of adolescent stress and depression opens the door for adults to begin constructive interventions and stimulate emotional development.

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INDIVIDUALS WITH PARALYSIS AND THEIR CAREGIVER'S PERCEPTION ON THE COPING STRATEGIES WITH REGARDS TO SOCIALIZATION

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Paralysis is a complete inability to move, to sense touch, or to control bodily sensations. There are four main categories of paralysis, which have to do with the portion of the body that is affected, namely monoplegia, hemiplegia, paraplegia, quadriplegia. Objectives include: a) to study the coping strategies used by the individuals with paralysis b) to ascertain the perception of individuals with paralysis on the impact of coping strategies on their socialization c) to ascertain the perception of caregivers regarding the effect of coping strategies on the socialization of individuals with paralysis. In all 44 participants were selected of which 21 were individuals with paralysis for more than two years to less than six years and 23 caregivers' providing care for more than two years. Two questionnaires were formulated to know the perceptions of a) individuals with paralysis b) their caregivers on coping strategies used by them regarding socialization. The tool consisted of open and close-ended questions. An exploratory research design, snowball and purposive sampling techniques were used. Tools were separately prepared for individuals with paralysis and their caregivers. Results revealed that the most common cause of paralysis was seen to be stroke. The coping strategies (psychological and physiological) used by individuals with paralysis were assisted walking, physiotherapy, meditation, etc. The coping strategies helped the individuals with paralysis to improve their social interaction. Caregivers perceive that paralysis has affected the individuals' socialization and the physical, social, emotional and mental health. According to caregiver's behavior and care provided, the recipient changes and the coping strategies help the individual with paralysis.

Key words: Paralysis, coping strategies on their socialization

REVIEW OF LITERATURE

Introduction to Paralysis

Paralysis is a complete inability to move, to sense touch, or to control bodily sensations. The real meaning of paralysis is significantly more nuanced. Paralysis is a loss of the ability to move one or more muscles. (<https://gradeup.co/shared-info-i-f02a7430-f666-11e6-aa5a-82a1e2ae1a4f>). People with paralysis cannot move one or more of their muscles. Paralysis results from conditions affecting the nerves and spinal cord that carry movement messages from the brain.

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Definitions of Paralysis

Paralysis is - Complete or partial loss of function especially when involving the motion or sensation in a part of the body, loss of the ability to move and a state of powerlessness or incapacity to act. (<https://www.healthline.com/health/paralysis>)

Causes of Paralysis

Strokes are the most common causes of paralysis because of their ability to injure the brain and impede its relationship with the spinal cord. Spinal cord injuries can be due to car accidents, falls, sporting injuries and interpersonal violence. Strokes, spinal cord injuries, multiple sclerosis, cerebral palsy, post-polio syndrome, traumatic brain injury, neurofibromatosis, birth defects (<http://www.spinalcord.com/types-of-paralysis>), Physical injury, Guillain-Barre syndrome, Cancer, Cerebral palsy, Friedreich's ataxia, Guillain-Barre syndrome, Lyme disease, motor neuron disease, spina bifida. (<http://www.humanillnesses.com/original/Pan-Pre/Paralysis.html#ixzz4oD4r70DX>)

Types of Paralysis

Monoplegia: Monoplegia is paralysis of a single area of the body, most typically one limb. People with monoplegia typically retain control over the rest of their body, but cannot move or feel sensations in the affected limb.

Hemiplegia: Hemiplegia affects an arm and a leg on the same side of the body, and as with monoplegia, the most common cause is cerebral palsy.

Paraplegia: Paraplegia affects the muscles below the waist, and usually the legs, the hips, and other functions, such as sexuality and elimination.

Quadriplegia: Quadriplegia, which is often referred to as tetraplegia, is paralysis below the neck. All four limbs, as well as the torso, are typically affected.

Symptoms of Paralysis

Hemiplegia is almost always caused by brain damage on the side opposite the paralysis, often from a stroke. Paraplegia occurs after injury to the lower spinal cord, and quadriplegia occurs after damage to the upper spinal cord at the level of the shoulders or higher (the nerves controlling the arms leave the spine at that level). Monoplegia may be caused by isolated damage to either the central or the peripheral nervous system. Weakness or paralysis that occurs only in the arms and legs may indicate demyelinating disease.

Complications of Paralysis

Paralysis may have an impact on a person's sex life and fertility. A person with paralysis has an increased risk of developing a pressure ulcer. (<http://www.nhs.uk/Conditions/paralysis/Pages/Complications.aspx>)

Personality and Behavior Changes of Person with Paralysis

Carney (2017) Healthy people differ significantly in their overall personality, mood, and behavior. Each person also varies from day to day, depending on the circumstances. However, a sudden, major change in personality and/or behavior, particularly one that is not related to an obvious event (such as taking a drug or losing a loved one), often indicates a problem.

Changes in personality and behavior can be roughly categorized as one of the following: confusion or delirium, delusions, disorganized speech or behavior, hallucinations, mood extremes (such as depression). These categories are not disorders. They are just one-way doctors organize different types of abnormal thought, speech, and behavior. People may have more than one type of change. For example, people with confusion due to Alzheimer disease sometimes become depressed, and people with delirium may have disorganized speech or hallucinations.

(<http://www.merckmanuals.com/home/mental-health-disorders/overview-of-mental-health-care/personality-and-behavior-changes>.)

Coping Strategies for the Individuals with Paralysis

Devereux, Bullock and group (2005): Social support is very important for individuals suffering from paralysis, yet they have reported having low levels of social support. The researchers conducted an in-depth interview with individuals who report high levels of social support to examine what supports this protective factor. Because relationship affects social support, the researchers also examined the importance of reciprocity, maintaining autonomy, and a positive outlook for sustaining support. In their responses, people with high support emphasized that they do all they can to affect their environment positively so that ideally, the only assistance that they cannot provide themselves is successfully obtained from others.

(<http://journals.sagepub.com/doi/abs/10.1177/1049732305282200>)

Buunk (2007): A research was conducted on people with spinal cord injury to know the prevalence, coping and depression among them using social comparison technique. The individuals showed positive response seeing others who were worse than them, followed by a positive response to perceiving themselves better than others; a negative response to social comparison technique was that the individuals suffering from paralysis perceived themselves as worse than others followed by a negative response to seeing others who were better than them. Those who had less severe spinal cord injury reported the highest levels of coping by blaming others and depression. While those who had severe spinal cord injury felt bad as a response to seeing that others are better than them and this lead to depression.

(<http://www.tandfonline.com/doi/abs/10.1080/14768320500444117>)

Slaman, Emons and Meeteren (2014) The article talks about six-month lifestyle intervention that consisted of physical fitness training combined with counselling sessions which focuses on physical behavior and sports participation, fatigue, social participation, quality of life and gross motor

functioning. This lifestyle intervention was effective in decreasing fatigue severity during the intervention and in increasing health-related quality of life with respect to bodily pain and mental health during follow-up. Furthermore, the domain participation and involvement of the social support increased during both the intervention and follow-up period. The substantial mediating effects were found for physical behaviour and physical fitness on fatigue, bodily pain and mental health. (<http://journals.sagepub.com/doi/abs/10.1177/0269215514555136>)

Caregiver Related Articles

International Journal of Psychological Research, (2014) studied that ‘the burden of caregivers and their quality of life involved in helping individuals with diseases physical, mental and both pathological conditions’. Results show that both the burden and the quality of life are significantly worse for caregivers who care for individuals with paralysis who is both physically and mentally ill. Caregivers who cared for individuals for professional purpose showed more negative results. (http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S2011-20842014000100004)

Rationale of the Study

As innumerable studies have been conducted to study the various topics in the field of paralysis, but coping strategies with regard to the socialization of the individual with paralysis was untapped as a research area. Hence the researchers choose this topic to gauge the perception of individuals with paralysis, their caregivers about the effects of paralysis on the individuals’ socialization.

Why individuals with paralysis?

The researchers chose the Individuals with paralysis for the research study because they are the ones going through the disability, so they will be able to explain the difficulties faced by them better than their facilitators. They can provide authentic information about the coping strategies that they are using in their socialization, and whether these are helping them to cope with their socialization.

Why the caregivers of individuals with paralysis?

Caregivers are the most important persons after the doctors in the individuals’ life because they are the ones who look after them. Their perception does matter because the individual with paralysis may not realize the behavioral changes that the individual may have undergone which the caregiver will identify distinctly. Also, the caregivers play an important role in assisting the individual post-paralysis for all their basic needs. Thus, the caregivers’ perception with regard to the socialization of the individual with paralysis makes the research more authentic.

Why the coping strategies employed by individuals with paralysis?

Coping strategies was tapped by the researchers as it facilitates the individual to overcome the disability and be away from the negativity that he/she might develop about his/her life. This research may help the individuals and also develop effective strategies for the individual’s better and positive survival.

Why the coping strategies employed by the Individuals with Paralysis with regard to their socialization?

Among all different coping strategies that an individual requires to overcome the disability, the researchers tapped into socialization because, paralysis affects the movement, speech and mobility which are necessary requirements for socialization. This study may also help the non-paralytic individuals in the society understand the different types of coping strategies helpful for socialization for individuals with paralysis.

Objectives of the Study

Objective 1: To study the coping strategies used by the individuals with paralysis and their perception on the impact of coping strategies on their socialization

Objective 2: To ascertain the perception of caregivers regarding the effect of coping strategies on the socialization of individuals with paralysis.

METHODOLOGY**Research Design, Sample Size and Sampling Technique**

The study was an exploratory research design. There were total 44 participants selected for the research instead of 50 participants. Initially, the sample size was 30 individuals with paralysis, their 20 caregivers. The researchers selected 21 individuals with paralysis as the sample size as the researchers had a difficulty in finding 30 individuals with paralysis. The individuals with paralysis were included according to their feasibility of time and willingness to participate in the study. The individuals with paralysis who have had paralysis for 2-6 years i.e. (2 years 11 months) to (5 years 11 months) were selected. 23 caregivers were selected instead of 20 caregivers to participate in the study due to feasibility. The caregivers of only these individual with paralysis were selected. The caregivers like husband/ wife/ daughter/ mother/ father/ sister/ daughter in law of the individuals with paralysis and the caregivers at NGO's were included in the sample. The study involved snowball sampling technique and purposive sampling technique.

Inclusion Criteria**For Individuals' with Paralysis:**

- Individuals' who were paralyzed for more than 2 years to less than 6 years
- Participants that were residents of Mumbai
- Participants of all communities, castes, genders, religions and socioeconomic statuses were included

For the caregivers':

- The caregivers were included only if they were the caregivers' of those individuals' with paralysis that were selected for the research.
- They should be providing care to the individual with paralysis from at least 2 years.

- Participants of all communities, castes, genders, religions and socioeconomic statuses were included.

Exclusion Criteria**For an individual with paralysis:**

- Individuals with paralysis who have been paralyzed for less than 2 years and more than 6 years were excluded.
- Individuals with any other paralysis like facial paralysis, vocal cord paralysis, sleep paralysis, etc. except physical paralysis were excluded.
- Participants having any psychological disorder or other mental illnesses were excluded. The problems they have are totally different and may have additional challenges that may affect the result.

For caregivers:

- Caregivers who were giving care for less than 24 months were excluded.

Operational Definitions

Assistance: Experts facilitating the individual with paralysis to do their day to day work.

Behavioral changes: The transformation or modification of human behavior and the new habits that a person develops after having paralysis.

Caregiver: An individual, who provides care to the person with paralysis, can be paid or unpaid from the social network that facilitates the person in his/her activities of daily living.

Challenges: A difficulty or a thing that is hard to accomplish, deal with, or to understand.

Coping strategies: The conscious efforts made by the persons with paralysis, to solve personal and interpersonal challenges to try to master, minimize or tolerate stress and conflicts

Paralysis: Physical paralysis is a loss of muscle function in any part of the body which can be temporary or permanent and can be monoplegia, hemiplegia, paraplegia or quadriplegia.

Perception: The opinion of a person according to which something is regarded, understood, or interpreted.

Social relationships: The connections that exist between people and family members, friends, neighbors, coworkers, and other associates but excludes social contacts and interactions that are fleeting, incidental, or perceived to have limited significance

Socialization: The ability of the individual with paralysis of behaving in a way that is acceptable to the society and activity of mixing socially with others.

Therapy: Treatment(s) intended to relieve or heal a disorder(s).

Sample Characteristics of the Participants

Table 1: Sample characteristics of individuals with paralysis (n = 21)

Theme		Frequency	Percentage
Age	20 – 40	3	14.28%
	41 – 60	4	19.04%
	61 – 80	14	66.66%
Sex	Male	17	80.95%
	Female	4	19%
Marital Status	Married	14	66.66%
	Never Married	2	9.52%
	Not answered	5	23.80%
Number of years the individual has had paralysis	2 years	1	4.76%
	3 years	6	28.57%
	4 years	5	23.8%
	5 years	8	38.09%
	6 years	1	4.76%
Cause of paralysis	Stroke	16	76.19%
	Accident	2	9.52%
	Fever	1	4.76%
	Tension	1	4.76%
	Spinal cord injury	1	4.76%
	Cerebral palsy	0	0%
	Polio	0	0%
Onset	Sudden	19	90.47%
	Gradual	2	9.52%
Type of paralysis	Hemiplegia	16	76.19%
	Monoplegia	4	19.04%
	Tetraplegia	1	4.76%
	Quadriplegia	0	0%
	Paraplegia	0	0%

Theme		Frequency	Percentage
Part of body affected Note: Multiple responses were obtained	Hand	16	76.19%
	Leg	16	76.19%
	Neck	4	19.04%
	Spinal Cord	3	14.28%
	Brain	2	9.52%
	Upper half	2	9.52%
	Left side	1	4.76%
	Right side	1	4.76%
	Lower half	0	0%

Table 2: Sample characteristics for caregivers of individuals with paralysis (n = 23)

Theme		Frequency	Percentage
Age	15 – 30	2	8.69%
	31 – 45	11	47.8%
	46 – 60	7	30.43%
	61 – 75	3	13.04%
Sex	Female	18	78.26%
	Male	5	21.73%
Marital Status	Married	17	73.91%
	Unmarried	6	26.08%
Years the individual has been a caregiver	3 – 4	9	39.13%
	4.1 – 5	12	52.17%
	5.1 – 6	2	8.69%

Process of Initiating the Research

A group of five researchers was formed by the guide. The group then thought of some topics on which they would like to conduct a research and generated a list of research topics after searching for ideas from the internet, previous thesis, articles from which one broad category was selected. They thought of a specific area from the broad category with the help of the research guide on which they would carry the research on. After selecting the topic they started to collect articles and information on the topic to make the review of the literature and the methodology.

Procedure for Developing the Data Collection Tool

Preparing the Pre-screening proforma: The proforma was prepared based on the inclusion and the exclusion criteria of the study

Formulating the data collection tool: The questionnaire consisted of open and close-ended questions. There were two self-devised semi-structured questionnaires, one for individuals with paralysis and another for their caregivers. For the close-ended questions, yes-no questions were used.

Conducting the pilot study: A pilot study was conducted on 2 individuals, 2 caregivers based on the feedback given by them the questionnaire was modified as the subjects were not able to understand all the questions and asked for more clarification

Modification of the Data Collection Tools:

For an individual with paralysis:

The question on the challenges in the socialization of the individual post-paralysis was changed from an open-ended question to a close-ended question as many participants found it difficult to understand what the researchers were expecting. The question of using the personal mobility devices and the question of using any therapies and assistance were overlapping hence it was removed.

For the caregivers:

The question for changes in behaviour and changes in social relations were overlapping hence it was removed from the questionnaire

Procedure for data collection: The sample size was 21 individuals with paralysis, 23 caregivers i.e. 44 participants. The researchers then started contacting individuals with paralysis, caregivers in the hospitals, NGO's, etc. For the data collection the researchers used the snowball sampling technique and purposive sampling technique, this helped them to get the participants easily. They had used different methods for collecting the data i.e. through e-mails, telephones, in-house survey's, social networking sites, personal contacts, etc. After the data collection, the forms were arranged category wise i.e. number of individual with paralysis, their caregivers. They then numbered the forms accordingly for initiating the evaluation process. The researchers then evaluated the questionnaires of the individual with paralysis, their caregiver's questionnaires.

Plan of Analysis

Data was mainly quantitatively analysed. The plan of analysis was done for different objectives of the study by extracting themes and calculating the frequency and percentage. There were open-ended and close-ended questions across both the questionnaires.

RESULT OF THE STUDY

Forms of Socialization Used by the Individuals with Paralysis

When asked, the individuals with paralysis regarding the forms of socialization used by them almost all the participants (95.23%) indicated that they used face to face communication; little more than one third of the participants (42.85%) indicated that they communicated using the phone while a very few

of the participants indicated that they used a. social networking (14.28%) and b. communication via action (4.76%). [Refer to Table 3]

Table 3: Forms of socialization used by the individuals with paralysis (n = 21)

Forms of socialization	Individuals With Paralysis <i>f</i> (n=21)	%
Communicating face to face	20	95.23%
Communicating on phone	9	42.85%
Social Networking	3	14.28%
Communicating through action	1	4.76%

Note: Multiple responses were obtained

Challenges in Socialization Faced by the Individuals, Post Paralysis

When asked, the individuals with paralysis regarding the challenges in socialization faced by them post-paralysis almost all the participants (95.23%) indicated that walking was a major challenge; many of the participants (57.14%) indicated that talking was a challenge; while very few of the participants indicated varied responses as challenges a. exercise (4.76%), b. memory issue (4.76%) and c. doing any work with the right side (4.76%) [Refer to Table 4]

Table 4: Challenges in Socialization Faced By the Individuals, Post Paralysis (n = 21)

Challenges in Socialization	Individuals With Paralysis <i>f</i> (n=21)	%
Walking	20	95.23%
Talking	12	57.14%
Exercise	1	4.76%
Memory Issue	1	4.76%
Doing any work with the right side	1	4.76%

Note: Multiple responses were obtained

Coping Strategies Employed by Individuals with Paralysis to Overcome the Challenges Faced

When asked, the individuals with paralysis regarding the coping strategies used by them many of the participants (57.14%) responded that they used assisted walking; little more than half the participants (52.38%) responded that they used exercises/ physiotherapy; very few of the participants said that they used a. meditation (14.28%); b. sign language (9.52%); c. family support (9.52%); d. cellphones (9.52%); e. Ayurveda medicines (9.52%); f. reading (4.76%); g. music (4.76%); h. Being positive (4.76%); i. Being confident (4.76%) and j. watching more television (4.76%). [Refer to Table 5]

Table 5: The coping strategies employed by individuals with paralysis to overcome the challenges faced (n = 21)

Coping strategies employed	Individuals With Paralysis f (n=21)	%
Assisted Walking	12	57.14%
Exercises/Physiotherapy	11	52.38%
Meditation	3	14.28%
Sign Language	2	9.52%
Family support	2	9.52%
Use of cellphones	2	9.52%
Ayurveda Medicines	2	9.52%
Reading	1	4.76%
Music	1	4.76%
Being Positive	1	4.76%
Being Confident	1	4.76%
Watching more television	1	4.76%

Note: Multiple responses were obtained

Coping strategies helping the individual in improving their socialization

When asked, regarding whether the coping strategies they used helped them improve their socialization all the participants (100%) responded positively within which little more than one third of them (38.09%) said that there was an improvement due to the use of coping strategies and few of them (19.04%) said that they could go out and meet people. [Refer to Table 6]

Table 6: Coping strategies helping the individual in improving their socialization (n = 21)

Help provided by coping strategies	Individuals With Paralysis f (n=21)	%
Yes	21	100%
Improvement due to the use of coping strategies	8	38.09%
Can go out and meet people	4	19.04%

Note: Multiple responses were obtained

Changes in the Social Relationships of the Individuals after Being Paralyzed

When enquired, regarding the changes in social relationships post-paralysis many of the participants (57.14%) responded positively within which quarter of the participants responded with a. change in intensity of emotions (25%); b. cannot meet people (25%), few of the participants responded with a. institution helped improve their socialization (16.66%); b. better relations with caregiver and friends (16.66%) while very few of the participants responded with a. they started socializing with people with similar disability (8.33%); b. used to work in drama before (8.33%); c. became free and loves interacting with people (8.33%) and little more than one-third of the participants (42.85%) responded negatively to any change in their social relationships. [Refer to Table 7]

Table 7: Changes in the social relationships of the individuals after being paralyzed (n = 21)

Changes in the social relationships	Individuals With Paralysis <i>f</i> (n=21)	%
Yes	12	57.14%
Change in intensity of emotions	3	25%
Cannot meet people	3	25%
Institution helped in improving socialization	2	16.66%
Better relations with caregivers and friends	2	16.66%
Started socializing with people with similar disability	1	8.33%
Used to work in drama before	1	8.33%
Became free and loves interacting with people	1	8.33%
No	9	42.85%

Note: Multiple responses were obtained

Objective 3: To ascertain the perception of caregivers regarding the effect of coping strategies on the socialization of individuals with paralysis.

Perceptions of paralysis and its effects on the individual's socialization

A large majority of the participants (73.91%) perceived that paralysis affects the physical, social, emotional and mental health of an individual; few of the participants (17.39%) said that it makes the individual with paralysis dependent on the caregiver and very few of the participants (13.04%) said that the caregiver's workload increases. [Refer to Table 9]

A substantial majority of the participants (86.95%) responded positively while very few participants (13.04%) responded negatively Effects of paralysis on the individual's socialization. [Refer to Table 8]

Table 8: Perceptions of paralysis and its effects on the individual's socialization (n = 23)

Perception and Effect of Paralysis	Caregivers <i>f</i> (n=23)	%
<i>Perception of Paralysis</i>		
Affects the physical, social, emotional, mental health	17	73.91%
Makes the individual with paralysis dependent on the caregiver	4	17.39%
Caregivers workload increases	3	13.04%
<i>Effect of Paralysis</i>		
Yes, paralysis has affected an individual's socialization.	20	86.95%
Paralysis does not affect the socialization of the individual with paralysis.	3	13.04%

Note: Multiple responses were obtained

Perceptions of the coping strategies used by individuals with paralysis with regard to their socialization

Perceptions regarding the coping strategies used by individuals with paralysis with regard to their socialization, a large majority said that the coping strategies were helpful (82.6%) within which many of the participants said physiotherapy(57.89%); little more than one third of the participants said assisted walking(42.10%); few of the participants said a. willpower yoga and meditation (15.78%); b. support of friends and family (15.78%) and very few participants said a. counselling (5.26%) and b. Ayurveda medicines from Philippines (5.26%). Few of the participants (17.39%) also said that coping strategies are not helpful. [Refer to Table 9]

Table 9: Perceptions on the coping strategies used by individuals with paralysis with regard to their socialization (n = 23)

Perceptions on the coping strategies	Caregivers <i>f</i> (n=23)	%
Yes, coping strategies are helpful for the individual with paralysis with regard to their socialization	19	82.6%
Physiotherapy	11	57.89%
Assisted walking	8	42.10%
Willpower, yoga and meditation	3	15.78%
Support of friends and family	3	15.78%
Counseling	1	5.26%
Ayurveda medicines from Philippines	1	5.26%
No, coping strategies do not help the individuals with paralysis with regard to socialization	4	17.39%

Note: Multiple responses were obtained

Behavioral changes in the individuals with paralysis in relation to socialization

Almost all the participants responded positively (91.30%) within which majority of them said there was a negative impact of the coping strategies (61.90%) and little more than one-third of them said that there was a positive impact of the coping strategies (42.85%). Very few of the participants said that there was no change (8.69%) within which half of the participants said that the individual with paralysis spends more time with the family (50%). [Refer to Table 10]

Table 10: Behavioral changes in the individuals with paralysis in relation to socialization (n = 23)

Behavioral changes	Caregivers <i>f</i> (n=23)	%
Yes	21	91.30%
Negative impact of coping strategies	13	61.90%
Positive impact of coping strategies	9	42.85%
No	2	8.69%
Spends more time with the family	1	50%

Note: Multiple responses were obtained

Changes in the relationship between the caregiver and the care recipient after having paralysis

When asked, the caregivers of the individuals with paralysis regarding the changes in the relationship between the caregiver and the care recipient after having paralysis majority of the individual with paralysis (69.5%) said that there had been a change in the relationship within which many of the participants (56.25%) said that it positively affected the relationship between the caregiver and the individual with paralysis; little more than a quarter of the participants (31.25%) said that it negatively affected the relationship between the caregiver and the individual with paralysis; very few participants (6.25%) said that the caregivers workload had increased. Little more than quarter of the participants (30.5%) said that there has been no change in the relationship. [Refer to Table 11]

Table 11: Changes in the relationship between the caregiver and the care recipient after having paralysis (n = 23)

Changes in the relationship	Caregivers <i>f</i> (n = 23)	%
Yes	16	69.5%
Positively affects the relationship between the caregiver and individual with paralysis	9	56.25%
Negatively affects the relationship between the caregiver and individual with paralysis	5	31.25%
Caregivers workload has increased	1	6.25%
No	7	30.5%

Note: Multiple responses were obtained

DISCUSSION

A large majority of the participants said that coping strategies do help the individual [Individuals with paralysis (100%), caregivers (82.6%)], very few of the participants said that coping strategies do not help the individual [caregivers (17.39%)]. Similarly, the review revealed that physiotherapy being an important part of helping individuals with paralysis by making their lives independent as much as

possible. Physiotherapy should be started as soon as possible which will help in improving blood circulation and also relax muscles. Therapy focuses on helping the individuals with paralysis remain as much mobile as possible. Post paralysis period may include phases of anxiety, depression, denial, internalized anger and externalized hostility experienced by the individual (Khanka 2016). Depression is common among people who are paralyzed, but it's not normal -- becoming discouraged, grief-stricken or sad is normal, but depression represents a condition that is a health problem unto itself.

Most forms of depression, however, can be treated. (<https://www.prnewswire.com/news-releases/dealing-with-depression-while-living-with-paralysis-300098600.html>) The review also stated the article that talks about six-month lifestyle intervention consisting of physical fitness training combined with counselling sessions. (Slaman, Emons, and Meeteren, 2014)

The review disclosed that each person's behavior also varies from day to day, depending on the circumstances. However, a sudden, major change in personality and/or behavior, particularly one that is not related to an obvious event (such as taking a drug or losing a loved one), often indicates a problem. Changes in personality and behavior can be roughly categorized as disorganized speech or behavior and mood extremes (such as depression) (Carney 2017). In accordance to the review the current research revealed, a large majority of the participants saw a change in the individual's behavior post-paralysis [Individuals with paralysis (5.14%), caregivers (91.30%)] while quarter of the participants saw no change in the individual's behavior post-paralysis [(Individuals with paralysis (42.85%), caregivers (8.69%)). The results of the treatment are not permanent because the patient may suffer from a relapse even after showing considerable improvement. This is primarily because paralysis is a nervous system problem, the cure, and treatment for which is hard to find. (<https://www.lybrate.com/topic/paralysis>)

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ASSISTIVE TECHNOLOGY IN GARDENING FOR CHILDREN WITH DISABILITY UNDERGOING HORTICULTURE THERAPY

Dr Beela G. K.¹ & Dr. V. Ganeshan²

Horticultural Therapy is an integrated approach to human development using horticulture with behavioural science. (Beela and Reghunath 2010) Several studies have shown that horticulture therapy resulted in an improvement in fine motor skills (Beela et al 2015), encourage creativity (Dorothy Blair 2009), and developed higher self-esteem. (Beela and Reghunath 2010) Horticulture or farming is considered to be an intensive occupation that involves physically demanding work. But if the proper assistive technology is used and devices are provided horticulture therapy can be made fun and easier for children. In order to implement horticulture therapy for physically challenged children, accessible gardening tools need to be developed which is ergonomically suitable for them. This study aimed to develop lightweight, flexible, and inexpensive gardening tools to implement horticulture therapy for physically challenged children with this objective some simple agricultural tools were developed after collecting and evaluating by the children with locomotor disability. The User-Centred Design (UCD) (User-Centered Design Basics 2017) was used in this study for designing the tools. The implementation of UCD method in this study involves four phases, namely, Analysis phase, Design phase, Implementation phase and Evaluation phase. The developed tools included cushion kneeler, tools with velcro, arm support cuff tools, gripping aids, T-handles and tools with extenders.

Keywords: Assistive technology, Horticultural therapy, Gardening tools.

INTRODUCTION

Any technology that helps an individual with disability to carry out a functional activity is defined as Assistive technology. (Robert et al 2012) It can be low tech or high tech, but helping a person with disability to complete a job. (Mukherjee et al 2008) Assistive technologies (AT) in agriculture is the application of ergonomics that can help in increasing the efficiency and thereby productivity of the people with disability. (Vijaya et al 2013) As per the Manual on Disability Statistics 2012 and National Sample Survey Organization 2003, in India there are more than 50 million children with disability. Despite the belief that these children should share the same quality of life as all children there are no assistive devices or garden tools specially designed and built for children with disabilities. Horticulture is an area neglected by the physically challenged populations due to the physical limitation. When physical challenges are making gardening difficult, then one needs to be creative in order to continue gardening without excessive pain or further injury to joint and tissues. Recently Horticulture therapy is widely applied all over the world. The results of several studies on horticulture therapy reveals that the subjects are more easily cured of their ailments(Mark et al 2012, Matilda et

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al 2011, Wang et al 2004) and have a positive and therapeutic influence on their psychology. (Gonzalez et al 2009, Rebecca and Hernandez 2007,) Research indicates that horticulture therapy techniques are effective in promoting mental wellness (Rebecca and Hernandez 2007) increase self-esteem (Beela and Reghunath 2010) and motor skills. (Jasmeen 2015, Beela et al 2015) The role of the horticultural therapy & the use of the natural environment as a model for the development of disabled children can help incorporating horticulture program in the special education curriculum.

If physically challenged persons can depend on special tools and methods of gardening suitable for their conditions, the individual as well as the society will be benefited. And it can play a partial role in meeting the food security. The intention of this research study is to develop assistive devices for gardening as well as standardizing it as per the feasibility study, considering that the tools developed will empower the children with disability and can streamline them towards a farming career.

Therefore the main objective of the current study was to develop lightweight, flexible, and inexpensive gardening tools to implement Horticulture Therapy for physically challenged children. The intention of this investigation was to develop and standardize horticulture therapy methods exclusively for the physically challenged with a locomotor disability.

Review of literature from around the globe has shown promise but in India, less research has been done in the field of horticulture therapy and there exists a wide gap in the quantity and quality of available literature in the country. This study will further add to the critical body of knowledge that is the departure point of more documented and empirical research necessary to enable appropriate tools and specific design recommendation for contemporary therapeutic garden designs.

METHODOLOGY

The methodology used in achieving the objective of the present study is discussed as follows:

Sample Selection

100 challenged children participating in the horticulture therapy project implemented by the Kerala Agricultural University was selected for this project.

Data Collection

A questionnaire to find out the ergonomic modification requirement in gardening tools were subjected to the hundred challenged children of the age group of 12 to 18 years.

Assistive Tools Selection Process

Based on the requirements collected from the sample five simple tools were selected for designing. The purpose of the devices is neither remediation nor rehabilitation but to enable the children with disability to carry out gardening in a safe and effective manner. The selected tools for designing and fabrication are as follows:

1. Cushioned Kneeler
2. Tools with Velcro strips
3. Straight handle tools
4. Tools with Extenders
5. Arms Support Cuff tools

The numbers of steps that were followed during the selection of the device were detailed information on the skills, abilities and special needs of the children was collected and evaluated.

Assistive Tools Design Process

The User-Centred Design (UCD) was used in this study for designing gardening tools. UCD is one of the essential concepts in usability engineering and areas that set designing interactive application as their goal. UCD is a design that is based on actual requirements of users and comprises of task analysis, prototype development with users, evaluation, and iterative design. This study stated five objectives of UCD including (1) to identify and prioritize usability values with users (2) to match task requirements to design (3) to remove defects from the design, and from the requirements (4) to test against usability criteria and (5) to iterate design to continuously improve.

The implementation of UCD method in this study involves four phases, namely: (1) Analysis phase: This phase is to analyze in depth the gardening tools that to be developed. The elements and criteria of ergonomics needed for the disability were analyzed. (2) Design phase: In this phase, the tools were designed based on the elements and requirements mentioned by the children with disability selected in this study (3) Implementation phase: In this phase, the design was implemented into working systems ready to be used based on the received feedback from actual users. Certain modifications were carried out based on the feedback. (4) Evaluation phase: In this phase, the tools were again evaluated by the users and a usability test was also carried out.

Evaluation of the tools

An evaluation was done to gather valuable feedback from physically challenged children with loco motor disabilities without the rigor of formal usability testing. This study for evaluation involved

- i. 20 physically challenged children with loco motor disabilities,
- ii. Asking them to complete tasks on prototypes,
- iii. Observing them interact with the prototype,
- iv. Discussing accessibility issues with them.

A rating scale questionnaire was used to compose a complete list of descriptors that could possible underlie the ergonomics. Users evaluated and rated the tools on a three point scale e.g.: Comfortable - 2, discomfortable-1, Do not know -0.

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First some standard information was given “This questionnaire is about comfort and ergonomics in using the tools used for gardening. Comfort in using a tool occurs when using a tool gives a state or feeling of having relief, encouragement and enjoyment”.

Usability Testing

Usability testing was done for each tool developed. Qualitative data from twenty real users performing real tasks that is the children with locomotor challenges and with seven real professionals, that is farmers were collected during usability testing. The tools were subjected for rating by the two groups.

RESULTS

Out of the hundred participants who were selected for the gardening project , randomly selected twenty participants with locomotor difficulties evaluated the prototype tool developed and the evaluation score was consolidated and statistically analyzed using the mean score method . Table 1 shows the descriptors for each tool based on the mean rating score. From the table it is seen that descriptors such as reliable, functional and easy to use are most related to comfort in using the tools. Descriptors such as solid design, professional looks, styling and nice colour are less related to comfort but is their opinion.

Table 1: Descriptors of the Tools Based on the Evaluation Mean Score

Sl. No	Descriptors for evaluation	Cushioned Kneeler	Velcro Straps tools	Straight handle tools	T handle tools	Tools with Extenders	Arm Support cuff tool
1	Reliable	38.3	36.9	34.9	32.9	36.8	36
2	Functional	32.4	34.8	38.4	34.8	34.8	37.2
3	Easy to use	36.4	35.7	30.1	36.2	32.1	34.9
4	Force exerted from the tool	35.4	32.6	32.9	38.7	34.9	32.0
5	Safe	33.9	31.9	36.7	36.9	34.8	36.8
6	No pain	32.9	33.8	33.9	35.7	34.7	36.7
7	No blisters	35.0	38.1	34.6	34.6	35.8	38.7
8	Feels comfortable to use	39.1	38.4	38.1	37.9	34.7	34.5
9	No peek pressure on hand/leg	35.0	36.5	28.7	32.3	37.9	37.6
10	No body part discomfort	32.0	34.9	39.8	32.7	35.4	32.1

11	Comfortable working posture	33.8	38.7	38.9	34.8	34.8	34.2
12	Weight of tool is light	22.7	39.3	34.7	34.9	35.4	34.6
13	No slippery handle	36.2	32	34.8	34	32.8	36.4
14	Easy to take along	34.4	38.7	39.7	35.8	36.8	36.4
15	Solid design	25.9	38.4	35.7	34.9	37.31.85	37.5
16	Nice colour	23.9	33	33.8	32.1	34.8	34.5
17	Professional look	29.9	34.6	34.8	34.9	35.7	35.7
18	High quality tool	31.9	32.7	34	36.2	32.9	39.8
19	Task Performance	32.0	29	35.8	31	33.9	36.7
20	Lack of tactile feeling	31.9	27	37.8	30	34.5	36.8

The prototype tools that were rated high were finally fabricated and have been reported in this paper. Based on the evaluation and usability tests the devices were finally fabricated.

1. Cushioned Kneelers:

Kneelers were designed in such a way that it provides a cushion to the knees while working in beds and gardens. It is just a simple pad or a folding frame providing support when standing and turned over, a place to sit. It provides a very durable kneeling surface, provides handles to help push oneself up, converts to a sitting stool and folds compactly. (Fig. 1 and 2)



Figure 1: Cushioned Kneelers



Figure 2: Physically challenged child using Kneeler

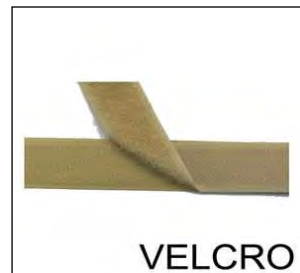
Table 2: Usability Tests for Cushioned Kneeler

User Satisfaction Dimension	No.	User Satisfaction Attributes	Rating Scores	
			Real users performing real tasks (n = 20)	Real professionals/farmers (n = 7)
Performance	1	Comfort to place the knees	4.37	4.29
	2	Precision	4.23	4.29
	3	Effectiveness	4.35	4.14
	4	Efficiency	4.40	4.14
	5	Productivity	3.93	3.43
	18	Grip comfort	4.32	3.43
	19	Grip friction	4.21	3.57
Physical Interaction	6	Durability	3.93	3.29
	7	Multi-function	2.81	2.00
	8	Handle shape	3.84	3.29
	9	Handle size	3.70	4.00
	12	Convenience/Portability	3.70	2.86
	13	Identification	2.95	2.14
	14	Maintenance	3.39	3.14
	15	All-weather proof	3.12	1.86
	17	Feedback	3.12	1.86
Affective Image /Impression	20	Luxurious	2.12	1.43
	21	Harmony	2.89	1.71
	22	Neatness	3.09	2.29
	24	Attractiveness	2.61	1.71
	25	Craftsmanship	3.12	2.00
	26	Prominence/Uniqueness	2.58	1.57
	27	Shape	3.33	2.57
	28	Color	2.60	1.43
	29	Texture	3.07	1.86
	30	Design/Styling	3.14	1.57

A total of 30 user satisfaction attributes associated with user satisfaction dimensions were employed as an input of the following stages of design process. Table 2 shows the list of user satisfaction attributes that was employed as input for fabricating the cushioned Kneeler.

2. Tools with Velcro Straps (Fig. 3 and 4)

Tools with Velcro straps were designed fixing Velcro straps to standard hand gardening tools for easy handling and to get a grip. Depending on the tool and how it is used, two straps were used. Terry cloth or other padding was also sewn to the side touching the skin for comfort. The straps were stapled and screwed to the handle of the tool.



(Figure 3: Tools Covered with Velcro) (Figure 4: Velcro)

3. Straight handle and T handle tool (Fig. 5 and 6)

Another adaptation done was by adding a 'T' handles to tools to provide extra control as well as a more comfortable gripping position. The 'T' is as simple as a large piece of dowel rod. A nicer touch is to use one that is tapered to fit more comfortably in the palm. These can be attached from the bottom with screws. A pre-drill hole through the tool handles to prevent it from cracking. Straight handle was a adaptation for accessibility and grip.



Figure 5 and 6: T handles and straight handles tools

Table 3: Usability Tests for the Hand Tools

User Satisfaction Attributes n=27		Hand tools					P-value ($\alpha=0.05$)
No	Criteria	A	B	C	D	E	
1	Comfort in using	3.67	3.00	3.13	3.13	4.40	0.000
2	Precision	3.73	3.00	3.40	3.33	3.73	0.042
3	Effectiveness	3.60	3.00	3.27	3.27	3.73	0.075
4	Efficiency	3.47	2.93	2.87	3.27	4.20	0.001
5	Productivity	3.60	3.00	3.00	3.20	3.73	0.032
6	Durability	3.27	3.27	3.33	3.67	3.40	0.233
7	Multi-function	2.93	2.73	2.73	2.93	3.00	0.865

8	Handle shape	3.33	3.00	3.27	3.20	3.60	0.734
9	Handle size	3.60	2.93	3.13	3.67	3.53	0.079
12	Convenience/Portability	3.73	3.13	3.13	3.40	3.60	0.206
13	Identification	3.20	3.60	3.67	3.80	3.20	0.132
14	Maintenance	3.87	4.00	3.87	3.33	3.40	0.020
15	All-weather proof	3.80	3.47	3.47	4.07	3.60	0.196
17	Feedback	3.33	3.33	3.33	3.67	3.73	0.357
18	Grip comfort	3.53	2.87	3.27	3.40	3.87	0.151
19	Grip friction	3.93	2.73	2.93	3.80	3.67	0.003
20	Luxurious	3.40	3.80	3.67	3.80	1.60	0.000
21	Harmony	3.80	3.53	3.67	3.60	2.93	0.079
22	Neatness	3.40	4.13	3.93	3.53	2.27	0.000
24	Attractiveness	3.67	4.13	3.73	3.73	1.87	0.000
25	Craftsmanship	3.67	3.40	3.53	3.87	3.27	0.377
26	Prominence/Uniqueness	3.13	3.67	3.53	4.33	2.27	0.000
27	Shape	3.87	3.53	3.60	3.60	3.20	0.432
28	Color	4.00	3.53	3.40	3.67	2.20	0.000
29	Texture	3.40	3.53	3.47	3.60	2.47	0.008
30	Design/Styling	3.67	3.67	3.60	3.87	2.00	0.000
Overall score		327.06	301.68	307.20	324.29	300.31	
Rank		1	4	3	2	5	

*Criteria in bold were significantly different over the hand tool types ($\alpha=0.05$)

A = Handle with Velcro

D = T handle hand tool

B = Tool without Velcro

C = Tool without any modification

C = Straight handle hand tool

Table 3 shows the average of rating scores and overall scores representing their subjective preference in terms of user satisfaction. As a result, type A, tool with Velcro (overall score = 327.06) was the most favorable or acceptable design while type B, tool without Velcro (overall score = 300.31) was the worst design in terms of user satisfaction.

4. Tools with Extenders

An extender to the gardening tools was attached which helped children who are restricted to a wheelchair or simply unable to bend or kneel down and work in gardens. (Fig. 7 and 8)

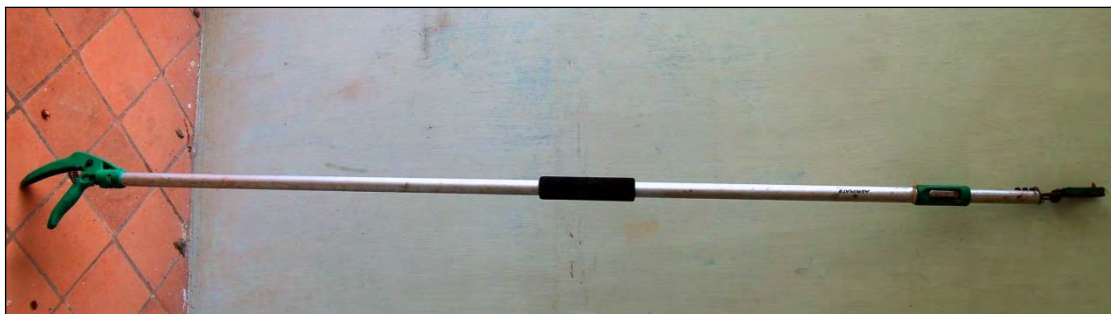


Figure 7: Tool with Extender with a V grip

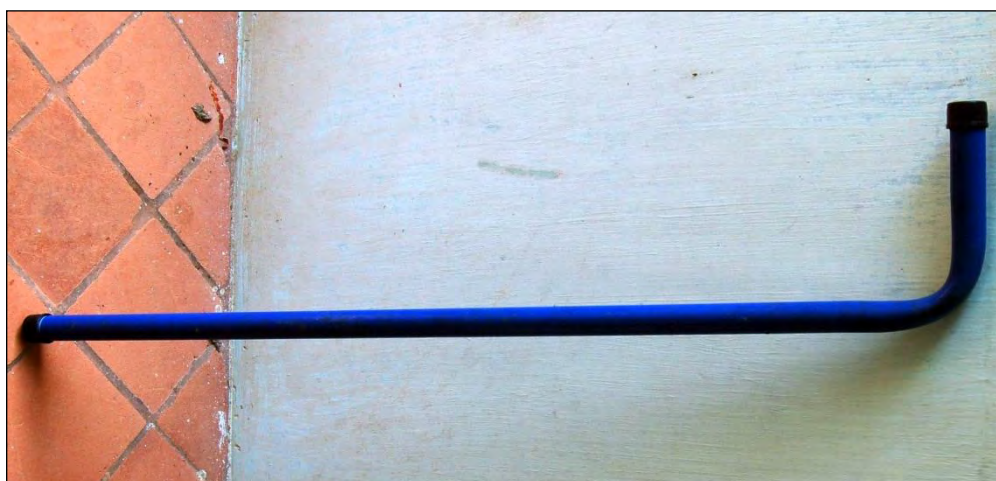


Figure 8: Tool with Extender with a bend handle

Table 4: Usability Tests for Tools with Extenders

User Satisfaction Attributes n=27		Tools With Extender				
		A	B	C	D	E
1	Performance	109.96	88.43	94.24	100.84	117.88
2	Rank	2	5	4	3	1
3	Physical Comfort	108.74	102.69	104.49	110.83	108.82
4	Rank	3	5	4	1	2
5	Affective Image/Impression	108.36	110.56	108.46	112.62	73.61
6	Rank	4	2	3	1	5
7	Overall Score	327.06	301.68	307.20	324.29	300.31
Rank		1	4	3	2	5

A = Tool with extender with a V grip
 B = Tool with extender without V grip
 C = Tool with extender and bend handle

D = Tool with extender and without bend handle
 E = Tool without extender

Table 4 shows the results with regard to the user satisfaction dimensions including “performance”, “physical comfort”, and “affective image/impression”, respectively. According to the result, tool without extender E was the best design in terms of “performance” user satisfaction dimension. However its overall score deteriorated due to the worst score of “affective image/impression” and physical comfort in using the tool. In other words, type E, the tool without extender could be accepted as the best design but with respect to the functional needs or requirements of users with locomotor challenges tools with extenders were more comfortable to use for them. Result of overall score indicated that type A (Tool with extender with a V grip) and C (Tool with extender with a bend handle) was the most acceptable design with intermediate ranks from all user satisfaction dimensions.

5. Arm Support cuff tool

An arm support cuff was designed and this tool has the handle at a right angle to the tool's head so that, whether one is weeding, planting or cultivating, wrists and hands are in a comfortable, natural position so that one doesn't drop the tool if they lose grip. (Fig. 9, 10, and 11)



Figure 9: Arm support cuff tool



Figure 10: Arm support cuff tool



Figure 11: Using Arm support cuff

In the usability tests for the Arm support cuff a total of 30 attributes were ranked on mean of their rating score. Among them, ratings of 11 attributes were significantly different between two groups (real users vs. professionals/farmers) from the Mann-Whitney Test ($\alpha=0.05$). Result of Spearman correlation analysis revealed that the ranks of two groups were significantly correlated ($r = 0.911$, $P < 0.001$). The results of questionnaire from each group are summarized in Table 2.

Table 5: Usability Tests for Arm Support Cuff Tool

No.	User Satisfaction Attributes	Real users performing real tasks (n = 20)			Real professionals/farmers (n = 7)			P-value ($\alpha=0.05$)
		Mean	SD.	Rank	Mean	SD.	Rank	
1	Reliable	4.38	0.85	4	4.29	0.49	1	0.378
2	Functional	4.22	0.79	7	4.29	0.76	2	0.905
3	Easy to use	4.38	0.73	5	4.14	0.90	4	0.496
4	Force exerted from the tool	4.44	0.64	2	4.14	0.90	5	0.395
5	Safe	4.00	1.05	9	3.43	0.98	8	0.159
6	No pain	4.02	0.89	8	3.29	1.11	10	0.077
7	No blisters	2.92	1.12	26	2.00	0.82	20	0.043*
8	Feels comfortable to use	3.92	1.14	10	3.29	0.95	11	0.119
9	No peek pressure on hand/leg	3.66	1.02	12	4.00	0.58	6	0.438
10	No body part discomfort	3.48	1.07	15	3.29	0.95	12	0.588
11	Comfortable working posture	3.62	0.92	13	3.00	1.41	14	0.377
12	Weight of tool is light	3.82	0.92	11	2.86	1.57	16	0.110
13	No slippery handle	3.06	1.20	24	2.14	1.46	19	0.058
14	Easy to take along	3.42	1.11	17	3.14	1.57	13	0.831
15	Solid design	3.30	1.22	19	1.86	1.46	22	0.009*
16	Nice colour	4.52	0.74	1	4.29	0.76	3	0.319
17	Professional look	3.30	1.13	20	1.86	1.21	23	0.008*
18	High quality tool	4.44	0.70	3	3.43	1.13	9	0.013*
19	Task Performance	4.30	0.76	6	3.57	0.98	7	0.050*
20	Lack of tactile feeling	2.22	1.37	30	1.43	0.79	29	0.169
21	Fit the work task	3.06	1.10	25	1.71	0.76	25	0.004*
22	Fit the working object and workspace	3.20	1.21	23	2.29	1.11	18	0.070
23	Look luxurious	3.60	1.14	14	3.00	1.41	15	0.263
24	Look simple	2.74	1.37	28	1.71	1.11	26	0.063
25	Look rigid	3.28	1.25	21	2.00	1.41	21	0.028*
26	Look salient	2.72	1.21	29	1.57	1.13	27	0.021*

27	Provide personalization	3.44	1.01	16	2.57	1.13	17	0.059
28	Provide Identification	2.76	1.30	27	1.43	0.79	30	0.011*
29	Attractive	3.24	0.82	22	1.86	1.21	24	0.005*
30	Stable	3.36	1.06	18	1.57	1.13	28	0.001*

Note: Attributes in bold were significant from the Mann-Whitney Test ($\alpha=0.05$)

CONCLUSION

Several attempts have been done in the past to develop assistive devices and several devices. There are several assistive gardening tools in the developed countries but hardly any such tool is found in the Indian Market. This study was an attempt to develop tools for the children with disability of Kerala who were participating in the Horticulture therapy project carried out by the Kerala Agricultural University. Hence the technology of the prototype developed in this study can be transferred to the manufacturers. The tool developed in this study can be manufactured in large scale so that children with disability can definitely take up agriculture as an occupation. Further research is required to develop more and lower tech as well as high tech assistive devices for the children with disability.

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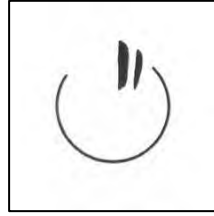
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