ISBN: 978-93-91768-21-8

Advances in Animal Science

Volume I

Editors

Dr. Sujata Magdum

Dr. Hema Makne

Dr. Rajendra Salunkhe

Dr. Vinda Manjramkar

Bhumi Publishing

Advances in Animal Science Volume I

(ISBN: 978-93-91768-21-8)

Editors

Dr. Sujata Magdum
PG Department and Research Center,
Department of Zoology,
KTHM College, Nashik

Dr. Hema Digamberrao Makne
Department of Zoology,
B. Raghunath A. C. S. College,
Parbhani

Dr. Rajendra Vishnu Salunkhe
Department of Zoology,
Arts, Science and Commerce College,
Indapur, Dist. Pune

Dr. Vinda Manjramkar
Department of Zoology,
B.N.Bandodkar College of Science
(Autonomous), Thane, Maharashtra

Bhumi Publishing

First Edition: 2021

ISBN: 978-93-91768-21-8

Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Book Available online at:

https://www.bhumipublishing.com/books/

PREFACE

We are delighted to publish our book entitled ***"Advances in Animal Science Volume I"****. This book is the compilation of esteemed articles of acknowledged experts in the fields of basic and applied animal science.*

This book is published in the hopes of sharing the excitement found in the study of animal science. Animal science can help us unlock the mysteries of our universe, but beyond that, conquering it can be personally satisfying. We developed this digital book with the goal of helping people achieve that feeling of accomplishment.

The articles in the book have been contributed by eminent scientists, academicians. Our special thanks and appreciation goes to experts and research workers whose contributions have enriched this book. We thank our publisher Bhumi Publishing, lndia for taking pains in bringing out the book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

- Editors

Advances in Animal Science Volume I

CONTENTS

TREATMENT OF METHANOLIC EXTRACTIVES OF PREPUPAL STAGES OF BLACK SOLDIER, *HERMETIAILLUCENS* L. (DIPTERA: STRATIOMYIDAE) FOR THE DMBA INDUCED HEPATIC AND BLOOD TOXICITY IN THE NORWEGIAN RAT, *RATTUS NORVEGICUS* (L).

Vitthalrao B. Khyade[1] and Avram Hershko[2]

[1](A): Sericulture Unit, Malegaon Sheti Farm, Agricultural Development Trust Baramati, Shardanagar, (Malegaon Khurd) Post Box No - 35, Baramati, Pune 413 115, M.S., India

[1](B): Head, Department of Zoology, Shardabai Pawar Mahila Arts, Commerce and Science College, Shardanagar Tal. Baramati Dist. Pune – 413115 India

[1](C): Dr. APIS", Shrikrupa Residence, Teachers Society, Malegaon Colony (Baramati) Dist. Pune – 413115 India

[2]Unit of Biochemistry, The B. Rappaport Faculty of Medicine,
The Rappaport Institute for Research in the Medical Sciences,
Technion-Israel Institute of Technology, Haifa 31096, Israel

Coresponding author E-mail: vbkhyade.2016@gmail.com, hershko@tx.technion.ac.il

Abstract:

Black soldier fly (BSF) is an extensively spread insect. Its larval stages are reducing the environmental pollution through utilization of organic waste for their development on organic wastes and converting the organic waste into protein and fat rich biomass. Health promoting potentials of black soldier fly derived proteins as ingredient of diet appears to be crucial need of modern days. In present attempt, forty Norwegian Rats were utilized as experimental animals. The individuals of experimental animals were divided into four groups. Each group was consisted of ten individuals of the experimental animals. The groups of the experimental animals include: Untreated control group; DMBA treated group; Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) Treated group and group treated with DMBA and Methanolic Extractives of Prepupal Stages of Black Soldier Fly (BSF) (DMBA + MEPSBSF). Experimental animals sacrificed at the end of experiment. The enzyme superoxide-dismutase (serves to breakdown the oxygen molecules of potentially harmful category); the enzyme glutathione-peroxidase (serving for reducing the hydrogen peroxide to water); the nitric oxide (compound responsible to cause widening of blood-vessels and stimulating hormones like insulin and growth hormone in human being); the enzyme myeloperoxidase (catalysing the

process of formation of a number of reactive oxidant species); enzyme Asparate-aminotransferase and the enzyme Alanine-aminotransferase are the parameters considered for bioassay from the serum. Histopathological study on liver tissue was evaluated. The level of activity of enzyme Asparate-aminotransferase; the enzyme Alanine-aminotransferase; the level of nitric oxide; myloperoxidein serum and the level of nitric oxide; myloperoxide in the liver tissue appear to be significantly higher in carcinogen induced toxicity. The level of activity of enzyme Asparate-aminotransferase; the enzyme Alanine-aminotransferase; the level of nitric oxide; myloperoxide in serum in the group of experimental animals in the group: "MEPSBSF + DMBA" in comparison with the group of experimental animals in "untreated control". The histological preparation of the liver tissue of the group of experimental animals in the group: "MEPSBSF + DMBA"reported less sinusoidal dilation; vacuolization in the cytoplasm of the liver cells (hepatocytes). There was inflammation around the central vein and in portal region in the group of experimental animals in the group: "MEPSBSF + DMBA". Methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) were reported to reduce the stress exerted through oxidation (oxidative stress). This may be through induction of mechanism of antioxidation process of the contents of Methanolic extractives of prepupal stages of black soldier fly (MEPSBSF). The present attempt on utilization of Methanolic Extractives of Prepupal Stages of Black Soldier (MEPSBSF) is reporting protective influence against the carcinogenic compounds like DMBA.

Keywords: DMBA, Oxidative Stress, Antioxidants, Histopathology, Hepatotoxicity, MEPSBSF.

Introduction:

The cancer is one of the remarkable disease leading causes of death in the world. The abnormal growth of cells appears to the distinguishing character of cancerous tissue. The microenvironment for cancer tissue is multifaceted and complex. The microenvironment for cancer tissue is composed of multiple cell types; the matrix of extracellular origin; the cells of stroma; the cells of endothelium and blood vessel like associated factors. The multiple cell types in cancer tissue include: neoplastic, normal, and reactive. The complex mixture of soluble factors in cancer tissue are derived from both the neoplastic cells and normal cell types. It is important to note that, the microenvironment of any tissue exert influence the quality of the growth. If this microenvironment of tissue is with carcinogens, it leads to exert an emergent tumor. The cancer tissue deserves the ability to modify its tissue microenvironment. Most of the cancer tissues have an inflammatory cell infiltrate. This cell infiltrate ranges from microscopic or the inflammation of subtle level (especially of a change or distinction; so delicate or precise as to be difficult to

analyse or describe). The gross inflammation of cell infiltrate is recognizable using standard histologic stains. The gross inflammation of cell infiltrate [1]. In a real sense, cancer tissue is formed through the group of diseased cells. The abnormal cell growth in cancer tissue is with the potential to invade or spread to other parts of the body. Formation of a lump; bleeding with abnormal rate; cough for prolonged duration; loss of body weight (without understanding the cause) and changes in the movements of bowel are some of the signs and symptoms of cancer. The factors responsible for the initiation and growth of cancer are recognized as, the "Carcinogens". The carcinogens are with ability of damaging the genome and / or disrupt the cellular metabolism. Miyata, *et al*[2], reported the immunosuppressive activity of the 7,12-Dimethylbenz [a] anthracene (DMBA) is an immunosuppressor and recommended as a powerful organ-specific to be used for studies in laboratory as carcinogen. Therefore, 7,12-Dimethylbenz [a] anthracene (DMBA) is widely used in number of attempts of cancer researches and laboratories for the studies of the cancer. The 7,12-Dimethylbenz [a] anthracene (DMBA) is working as a tumor initiator. Sung, *et al*[3] reported the tumour promotion through the treatment of 12-O-tetradecanoylphorbol-13- acetate (TPA). The 12-O-tetradecanoylphorbol-13- acetate (TPA)permits the tumour growth of accelerated rate. The 12-O-tetradecanoylphorbol-13- acetate (TPA) like carcinogens are serving a lot for the possibilities in cancer studies.

United Nation's Food and Agriculture Organization (FAO) [4] is a specialized and significant agency. It is leading in international efforts to defeat hunger and for the improvement in the quality of nutrition and the security of the food. The United Nation's Food and Agriculture Organization (FAO) has estimated that by 2050, the population of the world is going to reach nine-billions. It is therefore, necessary to increase the food production at least by seventy percent. The meat production should also by hundred percent [4]. Then and then only, it may be possible to meet global demands. However, present agricultural practices appear to be insufficient with reference to sustainability. The importance of security of the food has been experienced by the world in the COVID-19 pandemic. During this COVID-19, many food processors and food supply chain stakeholders were shut down. This system exerted influence on creating a meat shortage and increasing food insecurity concerns. In addition, meat accounts for only fifteen percent of the total energy in the global human diet. Approximately eighty percent of agricultural land is used for grazing the animals and the production of livestock feed-fodder [5, 6]. The consumption of meat must be reduced by seventy percent. This reduction in meat consumption is to achieve sustainable food production systems and meet food security requirements [7]. Furthermore, according to Ziolkowska [8], food loss is one more challenge for

the food sustainability, food economics and the food nutritional status. Despite considerable progress in agricultural production, post-harvest practices and supply chain management, in United States, there is loss of thirty to forty percent of total food production. For the purpose to reduce wastage of available food, to increase the yield of production and for the provision of alternative sustainable protein moieties with minimum impact on environment, therefore, there is necessary to develop novel system of production of food production. According to Liceaga[9], one sustainable food system is entomophagy, or consumption insects as a food material by human being. As a part of a diet, the insect consumptions are widely followed in Asia, Africa and Latin America. Anaya, *et al*. [10] reported ninety five percent of the biodiversity for the insects. This figure represents the largest sector of fauna and have historically been consumed at various stages of their life cycle. In Zambia, Nigeria, and other African countries, the meat supply is insufficient. Insects are therefore, serving as a valuable source of protein in Zambia, Nigeria, and other African countries [11]. According to Van Huis [12], insects are with fifty to seventy one percent of proteins; thirteen to thirty three percent of fats and five to thirteen percent of fibres. In addition, insects are with low emissions and greenhouse gas production, excellent feed conversion ratios, low water consumption and inexpensive feed sources. That is to say, the insects serve as favourable candidates as alternative protein that may be developed for food and feed products. Acceptance of insects as source of food material by the human population (especially in western countries) appears to be the most important hurdle. Moreover, it is challenge for researchers. According to Borremans [13], through the fragmentation of the body of insects and inclusion in diet, ii is possible to consumers to accept as functional food. Ovissipour *et al*. [14] suggested application of enzymatic hydrolysis technology for protein recovery; production of a broad spectrum of food and production of feed ingredients. This method is going to produce functional food with improved and upgraded functional properties and protein nutritional value. From perspectives of a food science and technology, attempts have developed protein hydrolysates from different insects including cricket, *Gryllodes sigillatus* (L.) [15]; migratory locusts, *Locusta migratoria* (L.) [16]; mealworm, *Tenebrio molitor* (L.) [17] and black soldier fly (BSF), *Hermetia illucens* (L.) [18, 19, 20, 21, 22, 23, 24, 25]. For the antioxidant properties of black soldier fly (BSF) hydrolysates, there are reports through few attempts on the hydrolysis of black soldier fly (BSF) [19, 21].Caligiani, *et al*. [18] and Mintah [20], reported the method of chemical and enzymatic hydrolysis of BSF for extraction and characterization of different fractions for the antioxidant properties of black soldier fly (BSF). There are no reports on the analysis of properties of functional class; properties of antioxidation; values of nutrition and applied studies pertaining the extractives of prepupal stages of black

soldier fly (BSF). The present attempt aimed to evaluate the antioxidant and protective efficacies of utilization of the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) *Hermetiaillucens* L. (Diptera: Stratiomyidae) through the Norwegian Rat, *Rattus norvegicus* (L).

Material and Methods:

The study was carried through the steps, which include: Nurturing (Rearing) of the black-soldier-fly, *Hermetia illucens* (Linnaeus) (Order: Diptera; Family: Stratiomyidae); Preparation of "Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF)"; Design of Experiment through Grouping the experimental animals; Processing for the assay sample preparation (Serum Assay Sample and Liver tissue homogenate); Biochemical Analysis; Histochemical studies and Statistical analysis.

(A). Nurturing (Rearing) of the black-soldier-fly, *Hermetia.illucens* (Linnaeus) (Order: Diptera; Family: Stratiomyidae): The present attempt on the rearing of the black soldier fly, *Hermetia.illucens* (Linnaeus) (Diptera: Stratiomyidae)in Baramati conditions of the environment was completed through the use available system at SharadanagarBaramati, Pune, India. The culture was initiated through keeping household organic waste (Kitchen Waste). The method of rearing belongs to Vitthalrao B. Khyade [22, 23, 24];V. B. Khyade and A. B. Tamhane [25]. Recommendations for rearing BSF Larvae by the researchers [26, 27, 28, 29, 30, 31] were also considered in present attempt. The observations were recorded on egg hatching; the period of development of the larval, pupal and adult stages and the morphology of the life stages. The sex ratio was determined through random sampling performance and observations of the genitalia of randomly collected adults.

(B). Preparation of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF): The mature pre-pupal life stages of the Black-Soldier-Fly (BSF), *Hermetia.illucens* L. (Order: Diptera; Family: Stratiomyidae) were selected randomly from the stock culture. They were kept in freezer at -35^{o}C for twenty-four hours. After twenty-four hours of freezing, they were subjected for thawing followed by washing thoroughly. The content was then processed for drying for forty-eight hours in oven (60 °C). Through the use of blender, the oven dried pre-pupal stages of the Black-Soldier-Fly (BSF), *Hermetia.illucens* L. (Order: Diptera; Family: Stratiomyidae) were subjected for grinding until smooth. The content thus obtained was titled as, "Black-Soldier-Fly-Meal" (BSF Meal). For the purpose to prepare the extractives from "Black-Soldier-Fly-Meal" (BSF Meal), methanol was selected as solvent. Ten milligrams of "Black

Soldier Fly Meal" (BSF Meal) were mixed in hundred millilitres of methanol. The contents were kept for twenty-four hours at room temperature for maceration. The method of obtaining extractives through the maceration belongs to Choi, *et al*. [43]. After twenty-four hours of maceration, the content was filtered through the use of common laboratory filter paper. For the purpose to obtain extractives in concentrated form, the filtrate was subjected for evaporation. Rotary evaporator was utilized. This evaporator was with a reduced pressure and temperature of 40°C [22, 23, 24, 25].

Rearing of Brown rat, *Rattus norwegicus* (L), the Experimental Animals: For the present attempt on utilization of the methanolic extractives of prepupal stages of Black Soldier Fly (MEPSBSF) *Hermetiaillucens* L. (Diptera: Stratiomyidae) for treatment in theexperimental animals) of the class of toxicity through the DMBA carcinogen, rats (*Rattus norvegicus* L.), fifty adult females (12 weeks-old) Brown rats (Rattus norvegicus L) (Dr APIS Laboratory), weighing 170 - 220 g were procured from the Department of Zoology, Savitribai Phule Pune University. The adult female rats were housed in quiet cages (20 - 25°C; 50 - 60% relative humidity). They were kept in laboratory with a condition of "12 hours light/dark cycle (7 a.m. - 7 p.m.)". They were fed with a commercial standard rat diet (AbalioguYemSanayi, Denizli, Turkey) and water ad libitum. All animal procedures were approved by the Animal Care and Use Protocol (Department of Zooloy, Shardabai Pawar MahilaMahavidyalaya, ShardanagarBaramati)[22, 23, 24, 25].

(C). Design of Experiment Through Grouping the Experimental Animals: Total fifty adult female brown Norwegian rat, *Rattus norvegicus* (L) (12 weeks-old) Brown rats weighing 170 - 220 g were procured from the Department of Zoology, Savitribai Phule Pune University. They were housed in quiet cages (20 - 25°C; 50 - 60% relative humidity). They were kept in laboratory with a condition of "12 hours light/dark cycle (7 a.m. - 7 p.m.)". They were fed with a commercial standard rat diet (AbalioguYem Sanayi, Denizli, Turkey) and water ad libitum. All animal procedures were approved by the Animal Care and Use Protocol (Department of Zoology, Shardabai Pawar MahilaMahavidyalaya, Shardanagar Baramati). The experimental animals were divided into four groups, each with ten individuals. Remaining ten individuals of experimental animals were maintained as reservoir. The individuals of group: first were served as untreated control group. The individuals of this untreated control group received 0.3 ml corn oil daily orally [22, 23, 24, 25].The individuals of the group: second were served as DMBA treated group. The rats in this group: second were supplied with 7,12- Dimethylbenz [a] anthracene (DMBA). The single dosage of DMBA at the rate 335 mg/kg of body weight was selected. The DMBA was given along with corn oil [44, 45, 46]; The individuals of group: third

were served as Methanol Extractives of Pre-pupal Stages of Black Soldier Fly (MEPSBSF) treated group. The rats in this group: third were supplied with methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF).The methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF) was given orally, 100 mg/kg/day every twenty-four hours. This MEPSBSF treatment was continued for seven days. The individuals of group: fourth were served as "DMBA + MEPSBSF treated group. The rats in this group were the recipient of single dosage of DMBA. The strength of DMBA dosage was of 335 mg/kg Body Weight. The rats in this group were also supplied with methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF). The number of dosages of methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF) was seven. Each dosage of methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF) was after every twenty-four hours. The strength of each dosage of methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF) was 100 mg/kg/day. The methanolic extractives of pre-pupal stages of black soldier fly (MEPSBSF) treatment were oral, at every twenty-four hours and it was for total seven days.

(D). Processing for the Assay Sample Preparation: At the end of the schedule of seven days of treatment, experimental animals were anesthetized. This anaesthetization was carried through two intra-periteoneal injections. The first intraperitoneal injection was of ketamine (60 mg/kg). The second intraperitoneal injection belong to xylazine (6 mg/kg). The gap between the two injections was fifteen minutes. Through the use of sterile tubes, the blood samples through intracardiac region were collected [47]

Preparation of Serum Sample for Biochemical Analysis: For the purpose of bioassay of the level of serum ALT, AST, MPO, NO, SOD and GPx, the blood samples were processed for centrifugation and serum preparation. Each blood sample was allowed for centrifugation at 2000 × G for 15 minutes, at 4°C. The serum, use to appear as the top yellow layer in centrifugation tube. This top yellow serum layer was pipetted out. Care was taken for keeping the white buffy layer (Serum was collected without disturbing the white buffy layer) [47].

Liver tissue from individual experimental animal in each group was removed immediately. The liver tissue was washed with phosphate buffer solution (PBS) (pH = 7.4). The liver tissue was processed for freezing (promptly in deep freezer. All the assay samples were allowed for protection through keeping them under -80°C until analysis [47].

Preparation of Liver Tissue Assay Sample for Biochemical Analysis: The experimental animals were anesthetized. This anaesthetization was carried through two intra-periteoneal injections. The first intraperitoneal injection was of ketamine (60 mg/kg). The second

intraperitoneal injection belong to xylazine (6 mg/kg). The gap between the two injections was fifteen minutes. The experimental animals were dissected. The liver from each individual was removed aseptically. The liver was processed for "Flash-freezing in foil packets using liquid nitrogen" and stored at –80°C. For the purpose to prepare homogenate, the liver sample was crushed on dry ice and stored in a prechilled 5 ml culture tube. Care was taken for the addition of about 100 µg tissue (enough to almost cover round portion of a 5 ml culture tube) to a new chilled tube. Addition of 1 ml PBS with 10 µl protease inhibitors (Sigma Cat. no. P-8340) was made. This solution then allowed for chilling using wet ice. The content was processed for homogenization at low speed for near about twenty seconds. The entire system was kept cold and tissue sample was kept on wet ice. The tissue sample was then transferred into 1.7 ml microcentrifuge tubes. It was the processed for centrifugation at 14,000 x g at 4°C for 15 minutes. The aliquot supernatant was separated and used as assay sample [47].

(E). Biochemical Analysis:

(1). Bioassay of Aspartate Aminotransferase and Alanine Aminotransferase Activities: The bioassay of activities of Aspartate Aminotransferase (AST) and Alanine Aminotransferase Activities (ALT) were carried out using the method of Kori-SiakpereOvie, *et al*[47]. The results were expressed as units per liter (U/L). Plasma alanine aminotransferase and aspartate aminotransferase were determined colorimetrically using commercial diagnostic kits (DialabProducktion, Austria) using a spectrophotometer (Spectrumlab 21A, Lenjguang Tech, China). Plasma alanine aminotransferase and aspartate aminotransferase were measured based upon International Federation of Clinical Chemistry (IFCC) recommendations by kinetic decreasing methods. Plasma aspartate aminotransferase was measured based on the process of "Oxido-reduction" (of NADH and NAD^+) through the presence of oxalo acetic acid. This system, further get resulted in the tendency of decrease in the optical density at 340 nm. The decrease in the optical density at 340 nmappears to be directly proportional to the aspartate aminotransferase in the sample (U/L). Plasma alanine aminotransferase was similarly measured based on the oxido-reductive process of NADH/NAD+ in the presence of pyruvate and the resulting decrease in absorbance at 340 nm being directly proportional to the alanine aminotransferase in the sample (U/L) [47]

(2). Bioassay of Superoxide Dismutase Activity: The assay kit, entitled, "Cayman's Superoxide Dismutase Assay Kit" was utilized for the determination of the activity level of the enzyme: Superoxide Dismutase (SOD).The detection of production of radicals of superoxide through the use of enzyme: xanthine oxidase and hypoxanthine. The definition for one unit of activity level of the enzyme: superoxide dismutase considered in the attempt was volume of source of the

enzyme required for fifty percent process of dismutation of the radicals of superoxide. The results on the activity level of the enzyme: Superoxide dismutases in the attempt were in terms of "Units per mg protein per mg tissue for the liver tissue. The results on the activity level of the enzyme: Superoxide dismutases in the attempt were in terms of "Units per millilitre for the serum. Recommended by the company for measuring formulation, the SOD was calculated by applying SOD values [47]

(3). Bioassay of Glutathione Peroxidase Activity: The tissue was homogenized in 5-10 mL cold buffer (50 mMTris-HCl) (The condition: pH of 7.5, 5 m Mole of EDTA, 1 m Moles of Dithiothreitol (DTT) per tissue). The content was the subjected for centrifugation at 10000 x G for fifteen minutes. It was followed by separation of supernatant. For the purpose to get serum sample, the blood was subjected for centrifugation (at 700 – 1000 x G) for ten minutes. The activity level of the glutathione peroxidase in serum sample and the assay sample from liver homogenate was carried out through the use of "GPx assay kit". The indirect coupled reaction with glutathione reductase was followed in the determination of activity level of the enzyme: Glutathione Peroxidase. There is release of oxidised glutathione in the process of reduction of hydroperoxide through the efficient catalysing enzyme: Glutathione Peroxidase. The activity level of the enzyme: Glutathione Peroxidase was expressed in the units per mg protein for assay sample of liver homogenate and units per millilitre for serum. Dynamic range of the assay is only limited by the absorbance measurement [47].

(4). Bioassay of Nitric Oxide (NO) Level: For the bioassay of level of Nitric Oxide, the tissue was processed for homogenization in phosphate buffer saline (PBS) (pH: 7.4). The content was processed for centrifugation (at 10000 x G) for twenty minutes. The supernatant was used as assay sample. The spectrophotometry (at 540 nm) was used for the determination of level of Nitric Oxide in assay sample. There was use of "Nitrate/ Nitrite Assay kit".

(5). Bioassay of Myeloperoxidase: The kit of "Enzyme Linked Immunosorbent Assay" (ELISA) was used for the determination of activity level of the enzyme: Myeloperoxidase from assay sample (MPO Instant Elisa eBioscience, Vienna, Austria) in Bio-TekELx- 800. The results were expressed as ng/mL protein [47].

(F). Histochemical Analysis of the Liver: For the histochemical analysis, the liver tissue was removed from the randomly selected and anaesthetized individual experimental animal from each group. The liver tissue was fixed in ten percent formaldehyde (formalin) and kept for twenty-four hours. Then, the tissue samples were processed for dehydration through the use of series of different dilutions of the alcohol. Finally, the tissue samples were cleaned in xylene and

processed for preparation of paraffin blocks of the tissue for the sections on microtome. The histological slides were prepared for histochemical analysis. The histochemical slides were observed through the use of light microscope. The method explained by Yehia, *et al*. [48] was used for the histochemical analysis of histological slides of liver tissue. The "Zero to three" was the scored followed ("0"- Normal; "1"-Mild; "2": Moderate; "3": Severe). It was further classified into three grades, such as I- 1-5, II- 6-10; III- 11-15 [49]. The sinusoidal dilation; distortion radial alignment around the central vein; vacuolization of hepatic cells; portal area inflammation and inflammation around the central vein; necrosis of hepatic cells and infiltration of eosinophils in theperiportal field and infiltration of eosinophils around the central [49].

(G). Statistical Analysis: The package of statistical software: "SPSS" was utilized for the analysis of the data (IBM Corp., Armonk, N).The mean and standard deviation were utilized for the tabular presentation of the data. The $P < 0.05$ was considered significantin the "t- Test" [50].

Results and Discssion:

The results of the attempt on utilization of the utilization of the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF)*Hermetiaillucens* L. (Diptera: Stratiomyidae) through the Norwegian Rat, *Rattus norvegicus* (L) are summarized in tables (table- 1 and 2) and presented in figures (Fig.1,2,3,4 and 5). The results are classified into two groups: Parameters of Serum and Parameters of Liver.

(A). Parameters of Serum: The biochemical parameters of serum include: Asparate-amino transferase (AST); alanine aminotransferase (ALT); Superoxide dismutase (SOD); Glutathione peroxidase (GPx); Myeloperoxidase (MPO) and Nitric oxide.

(A.1). Asparate-amino transferase (AST) and alanine aminotransferase (ALT):

The velocity of biochemical reaction catalysed by the enzymes like asparate-amino transferase (AST) and alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the untreated control group was found recorded 112.87 (± 17.503) and 57.811 (±13.679) units respectively (Table-1and Fig.1).

The velocity of biochemical reaction catalysed by the enzymes like asparate-amino transferase (AST) and alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the DMBA treated group was found recorded 141.79 (± 21.576) and 93.255 (± 19.786) units respectively (Table-1 and Fig.1). The percent increase in velocity of biochemical reaction catalysed by the enzymes like asparate-amino transferase (AST) and alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat,

Rattus norvegicus L.) in the DMBA treated group was found calculated 25.662 and 61.310 respectively.

The velocity of biochemical reaction catalysed by the enzymes asparate-amino transferase (AST) and the enzyme alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treated group was found recorded 107.63 (± 36.786) and 56.753 (± 23.495) units respectively (Table-1). There was -04.642 and -01.830 percent change in the velocity of biochemical reaction catalysed respectively by the enzymes asparate-amino transferase (AST) and the enzyme alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treated group

The velocity of biochemical reaction catalysed by the enzymes like asparate-amino transferase (AST) and alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with DMBA treatment followed by Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Group: DMBA+MEPSBSF) was found recorded 113.96 (± 38.293) and 59.782 (± 28.796) units respectively (Table-1and Fig.1). There was -00.965 and 03.409 percent change in the velocity of biochemical reaction catalysed respectively by the enzymes asparate-amino transferase (AST) and the enzyme alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.) in the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with DMBA treatment followed by Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Group: DMBA+MEPSBSF).

The DMBA treatment was found increase in the velocity of biochemical reaction catalysed by the enzymes like asparate-amino transferase (AST) and alanine aminotransferase (ALT) in the serum sample of the experimental animals (Rat, *Rattus norvegicus* L.). The DMBA treatment might have induced pathological changes in serum, resulting in elevation of velocity of biochemical reactions catalysed by asparate-aminotransferase (AST) and elevation of velocity of biochemical reactions catalysed by alanine aminotransferase (ALT) [51, 52, 53].

(A.2). Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO):

The enzyme, “Superoxide dismutase (SOD)” is working for the catalysis of superoxide radical into normal (ordinary) molecular oxygen and hydrogen peroxide. The radical of “Superoxide” is a product of metabolism of oxygen. The radical of “Superoxide”, if not

regulated, causes many damages in a cell [53]. The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of serum of the experimental animals (Rat, *Rattus norvegicus* L.) in the untreated control group was found recorded 6.983 (± 0.571); 3.867 (± 0.543) and 2.179 (± 0.347) units respectively (Table-1, Fig.2 and Fig.3).

The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver serum of the experimental animals (Rat, *Rattus norvegicus* L.) in the DMBA treated group was found recorded 11.287 (± 3.691); 5.462 (± 1.674) and 6.831 (± 1.786) units respectively (Table-1, Fig.2 and Fig.3). DMBA treatment was found effected into change in the velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver serum of the experimental animals (Rat, *Rattus norvegicus* L.) by 61.635 percent; 41.246 percent and 213.49 percent respectively.

The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of serum of the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) was found recorded 6.958 (± 1.239); 3.942 (± 1.357) and 2.183 (± 0.867) units respectively (Table-1, Fig.2 and Fig.3).

The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of serum of the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with both DMBA treatment followed by Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Group: DMBA+MEPSBSF) was found recorded 7.132 (± 2.528); 8.318 (± 1.639) and 2.176 (± 0.618) units respectively (Table-1, Fig.2 and Fig.3). The Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treatment is serving a lot to regularise the velocity of velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of serum of the experimental animals (Rat, *Rattus norvegicus* L.).

(A.3). Nitric oxide:

Nitric oxide is a compound in the body tissues. It uses to cause widening of the blood vessels. It also stimulates the tissue for the purpose to release of hormones (like insulin and growth hormones). The level of nitric oxide in the assay sample of serum of the untreated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 1.968 (±

0.251) units (Table-1 and Fig.3). The level of nitric oxide in the assay sample of serum of the DMBA treated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 5.233 (± 0.549) units (Table-1 and Fig.3). The level of nitric oxide in the assay sample of serum of the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 1.954 (± 0.448) units (Table-1 and Fig.3). The level of nitric oxide in the assay sample of serum of the group of animals treated with DMBA followed of the treatment with Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) in the attempt was found recorded 1.956 (± 0.697) units (Table-1 and Fig.3). The Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) may work as efficient "nitric oxide supplements" that offers several heart boosting effects. It is important to note here that, there should be trials on human being.

(B). Parameters of Liver:

(B.1). The biochemical parameters of serum include: Superoxide dismutase (SOD); Glutathione peroxidase (GPx); Myeloperoxidase (MPO); Nitric oxide and Histopathology.

The most significant organ affected by reactive oxygen species (ROS) in the body is the liver [54]. The injury in the liver lead to exert oxidative stress through the parenchymal cells, the primary cells. The cell organelle responsible for production of reactive oxygen species (ROS), regulating through the PPARα include: mitochondrion, microsomes and peroxisomes in parenchymal cells. It is mainly related to the expression of the genes of fatty acid oxidation. Potentially more exposed cells to the oxidative stress related molecules are *Kupffer* cells, hepatic stellate cells and endothelial cells. There is production of different Tumour Necrosis Factor alpha (TNF-α) like cytokines in the Kupffer cells. This production of cytokines by Kupffer cells is induced by stress through oxidation. This is responsible to increase inflammation and apoptosis. The oxidative stress is responsible to trigger the lipid peroxidation in the stellate type of hepatic cells [53, 54, 55, 56, 57]. Thereis disturbance in the homeostasis in the body through the excess level of reactive oxygen species (ROS). Further, the interplay of excessive level of reactive oxygen species (ROS) serves a critical role in the diseases concerned with the liver; chronic diseases and the degenerative disorders [58].

Table 1: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Biochemical Parameters of Serum in DMBA Induced Hepatotoxicity and Free-Radical Damage in Norwegian Rat, *Rattus norvegicus* (L).

Group	AST (U/L)	ALT (U/L)	SOD (U/m L)	GPx (U/m L)	NO (µm/ g)	MPO (ng/ mL)
Control	112.87 (± 17.503) 00.000	57.811 (± 13.679) 00.000	6.983 (± 0.571) 00.000	3.867 (± 0.543) 00.000	1.968 (± 0.251) 00.000	2.179 (± 0.347) 00.000
DMBA	141.79 (± 21.576) 25.622	93.255 (± 19.786) 61.310	11.287 (± 3.691) 61.635	5.462 (± 1.674) 41.246	5.233 (± 0.549) 165.904	6.831 (± 1.786) 213.49
MEPSBSF	107.63 (± 36.786) -04.642	56.753 (± 23.495) -01.830	6.958 (± 1.239) -00.358	3.942 (± 1.357) 01.939	1.954 (± 0.448) -00.711	2.183 (± 0.867) 00.183
DMBA + MEPSBSF	113.96 (± 38.293) -00.965	59.782 (± 28.796) 03.409	7.132 (± 2.528) 02.133	8.318 (± 1.639) 115.10	1.956 (± 0.697) -00.609	2.176 (± 0.618) -00.137

-Data is presented as Mean ± SD for n = 25. P < 0.05 SOD, "DMBA + MEPSBSF" compared with DMBA group. - P < 0.05 NO, "DMBA + MEPSBSF" compared with DMBA group. - P < 0.05 MPO, "DMBA + MEPSBSF" compared with DMBA group.

Table 2: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Biochemical Parameters of Liver in DMBA Induced Hepatotoxicity and Free-Radical Damage in Norwegian Rat, *Rattus norvegicus* (L).

Group	SOD (U/m L)	GPx (U/m L)	NO (µm/ g)	MPO (ng/ mL)
Control	1.786 (± 0.417) 00.000	1.239 (± 0.354) 00.000	3.861 (± 0.823) 00.000	4.773 (± 0.896) 00.000
DMBA	2.347 (± 0.479) 31.410	1.748 (± 0.049) 41.081	12.786 (± 1.419) 231.15	9.367 (± 1.632) 96.249
MEPSBSF	1.779 (± 0.758) -00.391	1.526 (± 0.437) 23.163	3.743 (± 0.598) -03.056	5.198 (± 0.764) 08.904
DMBA + MEPSBSF	1.731 (± 0.587) -03.079	1.354 (± 0.412) 09.281	3.913 (± 0.997) 01.346	5.073 (± 0.967) 06.285

-Data is presented as Mean ± SD for n = 25. P < 0.05 SOD, "DMBA + MEPSBSF" compared with DMBA group. - P < 0.05 NO, "DMBA + MEPSBSF" compared with DMBA group. - P < 0.05 MPO, "DMBA + MEPSBSF" compared with DMBA group.

Figure- 1: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Activity of Asparate-aminotransferase (AST) and Alanine aminotransferase (ALT) in Serum in DMBA Induced Toxicity in Norwegian Rat, *Rattus norvegicus* (L).

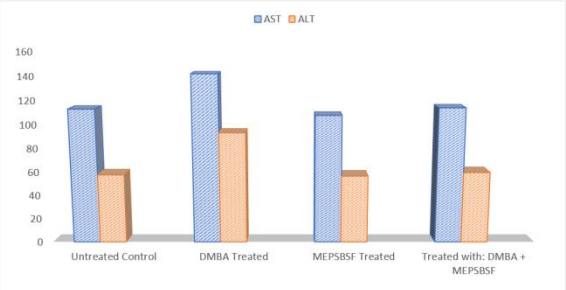


Figure- 2: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Activity of Superoxide dismutase (SOD) and Glutathione peroxidase (GPx) in Serum in DMBA Induced Toxicity in Norwegian Rat, *Rattus norvegicus* (L).

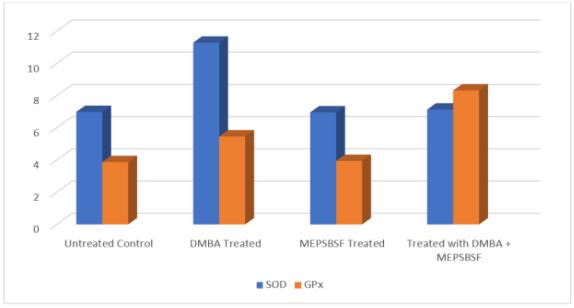


Figure- 3: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Nitric oxide (NO) level and Myeloperoxidase (MPO) activity in Serum in DMBA Induced Toxicity in Norwegian Rat, *Rattus norvegicus* (L).

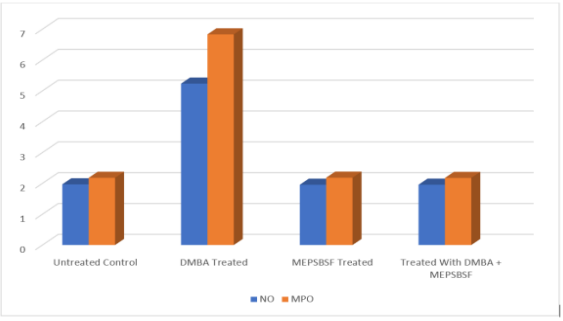


Figure- 4: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Activity of Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in Liver in DMBA Induced Toxicity in Norwegian Rat, *Rattus norvegicus* (L).

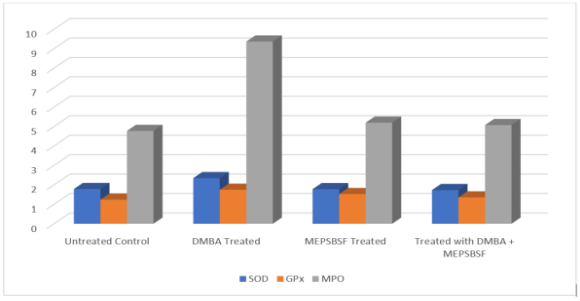
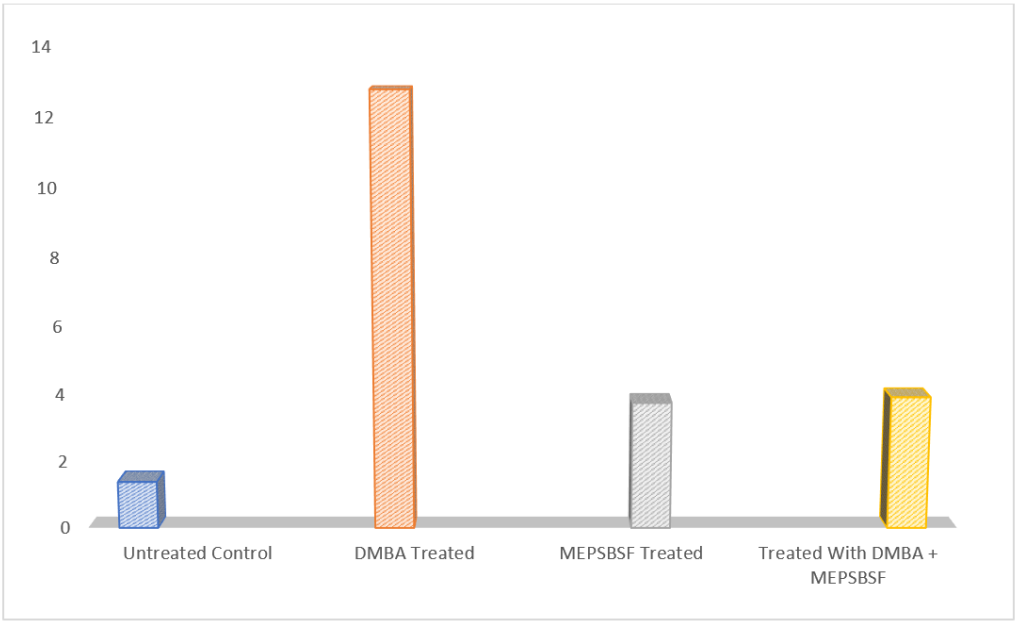


Figure- 5: Influence of Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) on Nitric oxide (NO) level in liver in DMBA Induced Toxicity in Norwegian Rat, *Rattus norvegicus* (L).



The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the untreated control group was found recorded 1.786 (± 0.417); 1.239 (± 0.354) and 4.773 (± 0.896) units respectively (Table-2 and Fig.4). The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in

the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the DMBA treated group was found recorded 2.347 (± 0.479); 1.748 (± 0.049) and 9.367 (±1.632) units respectively (Table-2 and Fig.4). There was 31.410 percent; 41.081 percent and 96.249 percent increase in the velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the DMBA treated group.

The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) was found recorded 1.779 (± 0.758); 1.526 (± 0.437) and 5.198 (± 0.764) units respectively (Table-2 and Fig.4). There was -00.391 percent; 23.163 percent and 08.904 percent change in the velocity of biochemical reaction catalysed, respectively by the enzymes Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treated group.

The velocity of biochemical reaction catalysed by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, Rattus norvegicus L.) in the group treated with both DMBA treatment followed by Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Group: DMBA+MEPSBSF) was found recorded 1.731 (± 0.587); 1.354 (± 0.412) and 5.073 (± 0.967) units respectively (Table-2 and Fig.4). There was -03.079 percent; 09.281 percent and 06.285 percent change in velocity of biochemical reaction catalysed, respectively by the enzymes like Superoxide dismutase (SOD); Glutathione peroxidase (GPx) and Myeloperoxidase (MPO) in the assay sample of liver homogenate of the experimental animals (Rat, *Rattus norvegicus* L.) in the group treated with both DMBA treatment followed by Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Group: DMBA+MEPSBSF).

Nitric oxide is a compound concerned with cause of the widening of the blood vessels. The nitric oxide stimulates the release of some hormones (like: insulin and growth hormones). The level of nitric oxide in the assay sample of liver homogenate of the untreated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 3.861 (± 0.823) units. The level of nitric oxide in the assay sample of liver homogenate of the DMBA

treated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 12.786 (± 01.419) units (Table-2 and Fig.5). The level of nitric oxide in the assay sample of liver homogenate of the Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) treated group of experimental animals (Rat, *Rattus norvegicus* L.) in the attempt was found recorded 3.743 (± 0.598) units (Table-2 and Fig.5). The level of nitric oxide in the assay sample of liver homogenate of the group of animals treated with DMBA followed of the treatment with Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) in the attempt was found recorded 3.913 (± 0.997) units (Table-2 and Fig.5). The Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) may work as efficient "nitric oxide supplements" that offers several heart boosting effects. It is important to note here that, there should be trials on human being.

The extent (the level) of the nitric oxide and the level of activity of the enzyme: myeloperoxidase in serum were observed significantly changed in the treated group, compared to control group ($P < 0.001$). The extents (levels) of the activities of the enzymes: Alanine-Aminotransferase and Asparate-Aminotransferase were observed to change significantly changed in treated group, compared to control group ($P < 0.001$). The levels of NO and MPO in serum were found to be significantly changed in DMBA + MEPSBSF group, compared with control group ($P < 0.01$ and $P < 0.001$).

(B.2). Histopathology of Liver:

Hepatocytes of control group (Figure 6 A) and the group treated with Methanolic Extractives of Prepupal Stages of Black Soldier Fly (MEPSBSF) (Figure 6 C) were observed to have a normal structure. The DMBA treatment was observed to damage the normal structural pattern of the liver (Grade 3). In histopathological examination, rats administered DMBA exhibitedsinusoidal-dilation (severe); disruption in the radial alignment of the hepatic cells (moderate); vacuolization in the cytoplasm of hepatic cells (severe) (fig. 6 B). In contrast, rats in the group treated with DMBA + MEPSBSF exhibited these changes significantly, especially inflammation around the central vein and portal space ($P < 0.05$). In histopathological examination, DMBA was found to cause to serve sinusoidal-dilation (severe); disruption in the radial alignment of the hepatic cells (moderate); vacuolization in the cytoplasm of hepatic cells (severe). The formulation prepared through the use of prepupal stages of black soldier fly in present attempt was observed significantly reversing the sinusoidal dilations(induced through DMBA treatment); vacuolization (severe) (induced through DMBA treatment) and

inflammations in the central vein (induced through DMBA treatment) in the tissue preparations of liver.

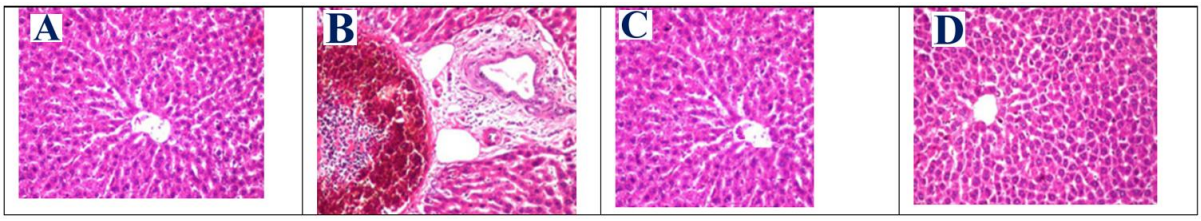


Figure 6: Histochemical Structure of Liver in Rat, *Rattus norvegicus* (L.). A: Untreated Control; B: DMBA Treated; MEPSBSF Treated and C: Treated with DMBA + MEPSBSF

The liver is essential and crucial organ in the body of vertebrate animals. The processes like detoxification are concerned with the liver. Through the assemblage of great amount of metabolite, the liver tissue is reported as the major site of DMBA metabolism (Giray, *et al*, 2001). The DMBA increased the reactive oxygen species (ROS) in liver tissue and methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) carries out free-radical-eliminating activity and extensive antioxidant effect.

Conclusively enough, the attempt demonstrates that, the methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) exert hepatoprotective, antioxidant, free radical scavenging effects against DMBA induced hepatotoxicity. It may also be suggested that the methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) is appropriate to be used as agent of amelioration of DMBA induced hepatotoxicity. It is necessary to study further for the purpose to understand the chemical components and quantify the beneficial effects of the methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) and it's possible clinical use.

Conclusion:

The present attempt on utilization of Methanolic Extractives of Prepupal Stages of Black Soldier (MEPSBSF) is reporting protective influence against the carcinogenic compounds like DMBA. Health promoting potentials of black soldier fly derived proteins as ingredient of diet appears to be crucial need of modern days. The level of activity of enzyme Asparate-aminotransferase; the enzyme Alanine-aminotransferase; the level of nitric oxide; myloperoxide in serum and the level of nitric oxide; myloperoxide in the liver tissue appear to be significantly higher in carcinogen induced toxicity. The level of activity of enzyme Asparate-aminotransferase; the enzyme Alanine-aminotransferase; the level of nitric oxide; myloperoxide in serum in the group of experimental animals in the group: "MEPSBSF + DMBA" in

comparison with the group of experimental animals in "untreated control". The histological preparation of the liver tissue of the group of experimental animals in the group: "MEPSBSF + DMBA" reported less sinusoidal dilation; vacuolization in the cytoplasm of the liver cells (hepatocytes). There was inflammation around the central vein and in portal region in the group of experimental animals in the group: "MEPSBSF + DMBA". Methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) was reported to reduce the stress exerted through oxidation (oxidative stress). This may be through induction of mechanism of antioxidation process of the contents of Methanolic extractives of prepupal stages of black soldier fly (MEPSBSF). Utilization of Methanolic extractives of prepupal stages of black soldier fly (MEPSBSF) may open a new avenue in the field of medicine.

Acknowledgements:

31st December is the birthday of Hon. Dr Avram Hershko (Israeli biochemist of Hungarian Jewish origin who received the Nobel Prize in Chemistry in 2004). Efforts of his kind self in raising the culture of science deserve appreciations and exert a grand salutary influence. With the best compliments from India, the present attempt is wishing Hon. Dr Avram Hershko "Happy Birthday".

References:

1. Rivenbark, A. G. and Coleman, W. B. (2014). An Introduction to the Conspicuous and Distinguishing Characteristics of Neoplasms. in Pathobiology of Human Disease, 2014A Dynamic Encyclopedia of Disease Mechanisms 2014, Pages 349-366. https://www.sciencedirect.com/science/article/pii/B9780123864567019018.
2. Miyata M; Furukawa M; Takahashi K; Gonzalez FJ; Yamazoe Y (2001). "Mechanism of 7, 12- Dimethylbenz[a]anthracene-Induced Immunotoxicity: Role of Metabolic Activation at the Target Organ". Jpn J Pharmacol. 86: 302– 309. doi:10.1254/jjp.86.302.
3. Sung YM; He G; Fischer, SM (2005). "Lack of Expression of the EP2 but not EP3 Receptor for Prostaglandin E2 Results in Suppression of Skin Tumor Development". Cancer Res. 65: 9304– 9311. doi:10.1158/0008-5472. can- 05-1015.
4. FAO. The State of World Fisheries and Aquaculture 2020; FAO: Rome, Italy, 2020; ISBN 978-92-5-132692-3.
5. Herrero, M.; Wirsenius, S.; Henderson, B.; Rigolot, C.; Thornton, P.; Havlík, P.; de Boer, I.; Gerber, P.J. (2015). Livestock and the environment: What have we learned in the past decade? Annu. Rev. Environ. Resour. 2015, 40, 177–202.

6. Herrero, M.; Henderson, B.; Havlík, P.; Thornton, P.K.; Conant, R.T.; Smith, P.; Wirsenius, S.; Hristov, A.N.; Gerber, P.; Gill, M. (2016). Greenhouse gas mitigation potentials in the livestock sector. Nat. Clim. Chang. 2016, 6, 452–461.
7. Kanianska, R. (2016). Agriculture and its impact on land-use, environment, and ecosystem services. Landscape Ecology— The Influences of Land Use and Anthropogenic Impacts of Landscape Creation. Kanianska, R., Ed.; Slovakia. 2016, pp. 1–26. https://www.intechopen.com/books/landscape-ecology-the-influences-of-land-useand-anthropogenic-impacts-of-landscape-creation/agriculture-and-its-impact-on-land-use-environment-andecosystem-services.
8. Ziolkowska, J. (2017). Economic and environmental costs of agricultural food losses and waste in the US. ETP Int. J. Food Eng. 2017.
9. Liceaga, A.M. Approaches for utilizing insect protein for human consumption: Effect of enzymatic hydrolysis on protein quality and functionality. Ann. Entomol. Soc. Am. 2019, 112, 529–532.
10. Anaya, J.-M.; Shoenfeld, Y.; Rojas-Villarraga, A.; Levy, R.A.; Cervera, R. Autoimmunity: From Bench to Bedside; El Rosario University Press: Bogota, Colombia, 2013; ISBN 9587383664.
11. Omotoso, O.T. Nutritional quality, functional properties and anti-nutrient compositions of the larva of Cirinaforda (Westwood) (Lepidoptera: Saturniidae). J. Zhejiang Univ. Sci. B 2006, 7, 51–55.
12. Van Huis, A. Potential of insects as food and feed in assuring food security. Annu. Rev. Entomol. 2013, 58, 563–583.
13. Borremans, A.; Bußler, S.; Sagu, S.T.; Rawel, H.; Schlüter, O.K.; Leen, V.C. Effect of Blanching Plus Fermentation on Selected Functional Properties of Mealworm (Tenebrio molitor) Powders. Foods 2020, 9, 917.
14. Ovissipour, M.; Rasco, B.; Shiroodi, S.G.; Modanlow, M.; Gholami, S.; Nemati, M. Antioxidant activity of protein hydrolysates from whole anchovy sprat (Clupeonellaengrauliformis) prepared using endogenous enzymes and commercial proteases. J. Sci. Food Agric. 2013, 93, 1718–1726.
15. Hall, F.G.; Jones, O.G.; O'Haire, M.E.; Liceaga, A.M. Functional properties of tropical banded cricket (Gryllodessigillatus) protein hydrolysates. Food Chem. 2017, 224, 414–422.
16. Purschke, B.; Meinlschmidt, P.; Horn, C.; Rieder, O.; Jäger, H. Improvement of techno-functional properties of edible insect protein from migratory locust by enzymatic hydrolysis. Eur. Food Res. Technol. 2018, 244, 999–1013.

17. Tang, Y.; Debnath, T.; Choi, E.-J.; Kim, Y.W.; Ryu, J.P.; Jang, S.; Chung, S.U.; Choi, Y.-J.; Kim, E.-K. Changes in the amino acid profiles and free radical scavenging activities of Tenebrio molitor larvae following enzymatic hydrolysis. PLoS ONE 2018, 13, e0196218.
18. Caligiani, A.; Marseglia, A.; Leni, G.; Baldassarre, S.; Maistrello, L.; Dossena, A.; Sforza, S. Composition of black soldier fly prepupae and systematic approaches for extraction and fractionation of proteins, lipids and chitin. Food Res. Int. 2018, 105, 812–820.
19. Firmansyah, M.; Abduh, M.Y. Production of protein hydrolysate containing antioxidant activity from Hermetiaillucens. Heliyon 2019, 5, e02005.
20. Mintah, B.K.; He, R.; Dabbour, M.; Xiang, J.; Hui, J.; Agyekum, A.A.; Ma, H. Characterization of edible soldier fly protein and hydrolysate altered by multiple-frequency ultrasound: Structural, physical, and functional attributes. Process Biochem. 2020, 95, 157–165.
21. Zhu, D.; Huang, X.; Tu, F.; Wang, C.; Yang, F. Preparation, antioxidant activity evaluation, and identification of antioxidant peptide from black soldier fly (Hermetiaillucens L.) larvae. J. Food Biochem. 2020, 44, e13186.
22. Vitthalrao B. Khyade (2021). Rearing the Black Soldier Fly, *Hermetiaillucens* (Linnaeus) (Diptera: Stratiomyidae) in local environmental conditions of Baramati (India). Uttar Pradesh Journal Of Zoology 42(5): 64-72, 2021 ISSN: 0256-971X (P). 262.khyade4252021upjoz718.pdf
23. Vitthalrao B. Khyade (2021). Larval Instars of Black Soldier Fly for Converting Food Waste into Livestock Feed. EC Veterinary Science 6.6 (2021): 50-53 https://www.ecronicon.com/ecve/pdf/ECVE-06-00401.pdf
24. Vitthalrao B. Khyade (2021). Utilization of the methanol maceratives of pre-pupal stages of the black soldier fly, Hermetiaillucens L. (Diptera: Stratiomyidae) For Inhibition Of Bacterial Growth. Uttar Pradesh Journal Of Zoology 42(14): 109-118, 2021 Issn: 0256-971x (P).
25. V. B. Khyade and A. B. Tamhane (2021). Utilization of the methanol maceratives of prepupal stages of the black soldier fly, *hermetia illucens* l. (diptera: stratiomyidae) for inhibition of bacterial growth. International Journal Of Researches In Biosciences, Agriculture And Technology. I J R B A T, Issue (Special-17), June 2021: 485-499 e-ISSN 2347 – 517X.
26. Pedro CD, Mehab H, Guillermo FDJ, Selin Y.Development of a Food waste Composting system using Black Soldier Fly larvae. 3rd annual R&D Student Competition-Greenovate NYS[Online]. Available. 2014, at: https://www.rit.edu(Accessed: 30th September 2018).
27. Briscoe AD, Chittka L. The evolution of color vision in insects. Annual Review of Entomology. 2001; 46:471-510.

28. Zhang J, Huang L, He J, Tomberlin JK, Li J, Lei C, Yu Z. An Artificial Light Source Influences Mating and Oviposition of Black Soldier Flies, Hermetiaillucens. Journal of Insect Science. 2010; 10:202.
29. Sheppard C, Newton GL, Thompson SA, Savage S. A value added manure management system using the black soldier fly. Bioresource Technology. 1994; 50:275-279.
30. Sheppard DC, Jeffery K, Tomberlin, Joyce JA, Kiser BC, Sonya M. 'Rearing Methods for the Black Soldier Fly (Diptera: Stratiomyidae)',J. Med. Entomol. 2002; 39(4):695-698.
31. Shields EB. Raising earthworms for profit. Eagle River, WI: Shields Publications, 1982.
32. Tomberlin Jeffery, Craig Sheppard D. Factors Influencing Mating and Oviposition of Black Soldier Flies (Diptera: Stratiomyidae) in a Colony. Journal of Entomological Science. 2002; 37:345-352.
33. Craig Sheppard D, Jeffery KT, John AJ, Barbara CK, Sonya MS.'Rearing Methods for the Black Soldier Fly (Diptera: Stratiomyidae)', J. Med. Entomol.2002; 39(4):695-698.
34. Savonen, Carol (2005-05-13). "Big maggots in your compost? They're soldier fly larvae". OSU Extension Service – Gardening. Oregon State University.
35. Spranghers, Thomas; Ottoboni, Matteo; Klootwijk, Cindy; Ovyn, Anneke; Deboosere, Stefaan; Meulenaer, Bruno De; Michiels, Joris; Eeckhout, Mia; Clercq, Patrick De; Smet, Stefaan De (2017). "Nutritional composition of black soldier fly (Hermetiaillucens) prepupae reared on different organic waste substrates". Journal of the Science of Food and Agriculture. **97** (8): 2594–2600. doi:10.1002/jsfa.8081. ISSN 1097-0010. PMID 27734508.
36. Lalander, C.; Diener, S.; Zurbrügg, C.; Vinnerås, B. (2019-01-20). "Effects of feedstock on larval development and process efficiency in waste treatment with black soldier fly (Hermetiaillucens)". Journal of Cleaner Production. **208**: 211–219. doi:10.1016/j.jclepro.2018.10.017. ISSN 0959-6526.
37. Wang, Yu-Shiang; Shelomi, Matan (2017-10-18). "Review of Black Soldier Fly (Hermetiaillucens) as Animal Feed and Human Food". Foods. **6** (10): 91. doi:10.3390/foods6100091. ISSN 2304-8158. PMC 5664030. PMID 29057841.
38. Goldson SL, Neill MRM, Proffitt JR, Baird DB. Seasonal variation in larval –instar head – capsule sizes of Argentine stem weevil, Listronotusbonariensis (kuschel) (Coleoptera;Curculionidae). Australian J Entomol. 2001; 40(4):371-375.
39. Mohammed SMG. Determination of Larval Instars of Black Cutworm Agrotisipsilon (Hufnagel) (Lepidoptera, Noctuidae)', JordanJournal of Biological Sciences. 2011; 4(3):173-176.
40. Bonelli, Marco; Bruno, Daniele; Brilli, Matteo; Gianfranceschi, Novella; Tian, Ling; Tettamanti, Gianluca; Caccia, Silvia; Casartelli, Morena (2020-07-13). "Black Soldier Fly Larvae Adapt to Different Food Substrates through Morphological and Functional

Responses of the Midgut". International Journal of Molecular Sciences. **21** (14): 4955. doi:10.3390/ijms21144955. ISSN 1422-0067. PMC 7404193. PMID 32668813.

41. Bruno, Daniele; Bonelli, Marco; De Filippis, Francesca; Di Lelio, Ilaria; Tettamanti, Gianluca; Casartelli, Morena; Ercolini, Danilo; Caccia, Silvia (2018-11-30). McBain, Andrew J. (ed.). "The Intestinal Microbiota of Hermetiaillucens Larvae Is Affected by Diet and Shows a Diverse Composition in the Different Midgut Regions". Applied and Environmental Microbiology. **85** (2): e01864–18, /aem/85/2/AEM.01864–18. atom. doi:10.1128/AEM.01864-18. ISSN 0099-2240. PMC 6328772. PMID 30504212.
42. Holmes, L. A.; Vanlaerhoven, S. L.; Tomberlin, J. K. (2013). "Substrate Effects on Pupation and Adult Emergence of Hermetiaillucens (Diptera: Stratiomyidae): Table 1". Environmental Entomology. **42** (2): 370–374. doi:10.1603/en12255. PMID 23575028.
43. Choi W, Yun J, Chu J and Chu K (2012). Antibacterial effect of extracts of *Hermetiaillucens* (Diptera: Stratiomyidae) larvae against Gram-negative bacteria 42219–26.
44. Shah MD, Iqbal M. (2010). Diazinon-induced oxidative stress and renal dysfunction in rats. Food ChemToxicol. 2010;48(12):3345–53.
45. Yilmaz N, Yilmaz M, Altuntas I. (2012). Diazinon-induced brain tox¬icity and protection by vitamins E plus C. ToxicolInd Health. 2012;28(1):51–7.
46. Teimouri F, Amirkabirian N, Esmaily H, Mohammadirad A, Ali¬ahmadi A, Abdollahi M. (2006). Alteration of hepatic cells glucose me¬tabolism as a non-cholinergic detoxication mechanism in coun¬teracting diazinon-induced oxidative stress. Hum ExpToxicol. 2006; 25(12):697–703.
47. Kori-SiakpereOvie; Ikomi Robert Bemigho and Ogbe Martin Gbemi (2010). Variations in alanine aminotransferase and aspartate aminotransferase activities in African catfish: Clariasgariepinus (Burchell, 1822) at different sublethal concentrations of potassium permanganate. Scientific Research and Essays Vol. 5(12), pp. 1501-1505, 18 June, 2010. ISSN 1992-2248 ©2010 Academic Journals.
48. Yehia Mona, A. H.; Sabah, G. El-Banna; Aly B. Okab (2007). Diazinon toxicity affects histophysiological and biochemical parameters in rabbits. Experimental and Toxicological Pathology. Vol. 59, Issue 3-4 November, 2007, Pages: 215 – 225.
49. Mysorekar, V. V., Rao, S. G., Mahadev, K. C. (2008). Liver histology in patient on hemodialysis with chronic hepatitis C viral infection. Indian J Pathol Microbiol 2008: 51 – 182-5.
50. Norman T. J. and Baily (1995). Statistical methods in Biology.
51. Taylor, W.H. Formol titration: An evaluation of its various modifications. Analyst 1957, 82, 488–498. [CrossRef] 20. Sathivel, S.; Smiley, S.; Prinyawiwatkul, W.; Bechtel, P.J.

Functional and nutritional properties of red salmon (Oncorhynchus nerka) enzymatic hydrolysates. J. Food Sci. 2005, 70, c401–c406.

52. Salem R, Lewandowski R, Roberts C, Goin J, Thurston K, Abouljoud M & Courtney A (2004) J VascIntervRadiol 15, 335-345.
53. Hayyan M, Hashim MA, Al Nashef IM (2016). "Superoxide Ion: Generation and Chemical Implications". *Chem. Rev*. **116** (5): 3029–3085. doi:10.1021/acs.chemrev.5b00407. PMID 26875845.
54. Sanchez-Valle V., Chavez-Tapia N.C., Uribe M., Mendez-Sanchez N. Role of oxidative stress and molecular changes in liver fibrosis: A review. *Curr. Med. Chem.* 2012; 19:4850–4860. doi: 10.2174/092986712803341520.
55. Sakaguchi S., Takahashi S., Sasaki T., Kumagai T., Nagata K. Progression of alcoholic and non-alcoholic steatohepatitis: Common metabolic aspects of innate immune system and oxidative stress. *Drug Metab. Pharmacokinet.* 2011; 26:30–46. doi: 10.2133/dmpk.DMPK-10-RV-087.
56. Cichoz-Lach H., Michalak A. Oxidative stress as a crucial factor in liver diseases. *World J. Gastroenterol.* 2014; 20:8082–8091. doi: 10.3748/wjg.v20.i25.8082.
57. Wu D., Cederbaum A.I. Oxidative stress and alcoholic liver disease. *Semin Liver Dis.* 2009; 29:141–154. doi: 10.1055/s-0029-1214370.
58. Li A.N., Li S., Zhang Y.J., Xu X.R., Chen Y.M., Li H.B. Resources and biological activities of natural polyphenols. *Nutrients.* 2014; 6:6020–6047.

UZHAVAR SANDHAI WASTE MANAGEMENT BY VERMICOMPOSTING

R. Jayashree

Department of Soils and Environment

Agricultural College and Research Institute, Madurai 625 104

Corresponding Author E-Mail: jayashree.r@tnau.ac.in

Abstract:

Production and marketing of vermicompost and its application to the crops has been assuming increasing importance in present days when the problems like land degradation, loss of soil fertility and raising cost of chemical fertilizers are besetting the farm sector. Though all the three aspects mentioned above are of paramount significance, much of the work done on vermicomposting relates to the production of this organic inputs and its effect on crop productivity, to the exclusion of economics involved in vermicompost production and its application to the crops. Suramangalam Uzhavarsanthai in salem district was started on 21.12.1999. It is one of the viable uzhavarsanthai amoung 11Uzhavarsanthai in salem district. The waste generated in this Uzhavarsanthai is composted by vermicomposting. The carbon nitrogen Ratio of partial decomposed waste is 30:1 and it is considerably reduced to 15:1 in vermicompost due to vermicomposting. The total cost including production cost and marketing cost for one metric ton of vermicompost is Rs. 3016. The price per metric ton is 5000/. And the net return per metric ton is 1984/-. The benefit cost rationof one metric ton of vermicompost of uzhavarsandhai waste is 1:1.66.

Keywords: Vermicompost-Uzhavarsandhai waste-Nutrients-Production cost- Benefit ratio

Introduction

In India's pre-independence era, agriculture was a system of harnessing nature for the sustenance of human beings, similar to the presently defined organic farming. Indian farmers relied on the use of crop rotation,crop residues, animal manures, legumes, green manures, off farm organic wastes and biological pest control to maintain soil productivity, supply plant nutrients and control insect, pest and weed on their farm. Rapid population growth after independence in India placed a great pressure on land and huge demands for food grains led to increased use of fertilizers and pesticides to boost production. Green revolution is a technology intervention in agriculture widely adopted by the farmers in developing countries led to increase in production. Expansion of irrigation to cover rainfed areas, popularization of

hybrids/transgenicvarieties of crops, and use of synthetic chemical fertilizers and pesticides were the major technologies promoted. This paid rich dividens in India, quadrupling food again production from 50 millions metric tonnes during 2016-17, enabling India to become self-sufficient in food grain

Since 1980's agricultural scientists in the world have been realizing the limitations of chemical fertilizers used for fertility management. While on the hand research is being intiated to improve the use efficiency of chemical fertilizers, on other hand alternative inputs are being considered. Organic matter recycling has been in use in India for centuries. The shift towards organic production is supported by consumers who are aware of health hazards: demand for food grown organically is increasing by 20-25% in developed countries where awarness is comparatively high. The organic agriculture is indeed being pursued in India; the national programme of organic products (NPOP) was launched in 2000. Its aim is mainly to create certification facilities; since its inauguration, 2.5 million ha (6.2 million acres) have been certified as orgainc, providing 115 to 238 metric tons of produced by the end of 2004-05 (Gauri 2005). Organic agriculture, a holistic system that focuses on improvement of soil health, use of local inputs, and relatively high-intensity use of local labour, is admirably fit for dry lands in many ways, and the dry lands offer many benefits that would make it relatively easy to implement.

The organic agriculture is key element for development and sustainable environment. It minimizes environmental pollution and the use of non-renewable natural resources and conserves soil fertility and soil erroson through implementation of appropriate conservation principles. Infact, India's National Project on Organic Farming (NPOF), launched in 2004, has given top priority to the dry lands (NPOF 2005). The real acheivement in organic method of farming has been in raising awareness among farmers, researches and policy makers in india about regenerative organic food production methods. In 1991-92 Department of Sciences and Technology promoted the adoption of vermicompost technology in 13 states in India. From 1997-98 onwards, several government agencies and NGOs are working individully to promote organic framing.

The awarness of organic matter and concept of sustaining agriculture is gaining impetus among our farmers in recent years to produce good quality consumable agricultural produce. In this context, recycling of available bio-wastes of different sources is helpful and can reduce the environmental pollution.

Uzhavarsandhai in Tamilnadu

Farmers market in Tamilnadu is called "**Uzhavarsandhai**" and was first started in Madurai. During the initial stages it was considered as highly successful and had the full lockup of farmers. Since it catered to the needs of small and marginal farmers, many such markets have been opened throughout Tamilnadu.

At present 179 Uzhavarsanthai are functioning with full vigor. The new concept of Uzhavarsandhai is implemented in Tamilnadu in massive scale. All Uzhavarsandhai are maintained by Agricultural Marketing Department and manned by the staff of the Department of Agricultural Marketing, Agriculture and Horticulture. The district collector is the coordinator for running the Uzhavarsanthai successfully in the Districts whereas in state as a whole, the scheme is implemented by the Director of Agricultural Marketing and Agribusiness, Chennai-32.

Model Uzhavarsandhai Waste management- Salem-Case study

In Salem District, there are 11 numbers of Uzhalavarsandhai are available and quantity of waste generated is presented in Table.1

Table 1: Quantity of decomposible waste accumulated in Uzhalavar sandhai in Salem District

Sl.No.	Uzhalavarsandhai Name	Quantity Kg/Week	Quantity MT/Month
1	Suramangalam	5500	22.0
2	Ammapet	2500	10.0
3	Attur	4500	13.0
4	Thathagapatti	3750	15.0
5	Aatayampatti	2000	8.0
6	Metur	2500	10.0
7	Hasthampatti	2800	11.2
8	Elampillai	1800	7.2
9	Thammampatti	1500	6.0
10	Jalagandapuram	1500	6.0
11	Edapadi	2000	8.0
	Total	30350	121.4

Vermicomposting is an option to manage the Uzhalavarsandhai waste:

Vermicomposting is an important component of organic farming without much financial involvement, which can convert rural and urban wastes into nutrient rich organic manures (Sajnanath and Sushama, 2004). Vermicomposting through organic farming is the pathway that leads us to live in harmony with nature. Vermicomposting is the secure system for agriculture. Use of this vermicomposting with increased efficiency by developing various methods which do not change the originality of the process i.e. use of earthworms for sustainable and secure system should be adopted. Several reasons have been emphasized for the need of organic agriculture including vermicomposting, like limited land holdings, poor socio-economic conditions of farmers, and rise in the input costs. The brodest view shows two major reasons viz., population and environment, emphasized the ultimate need for eco-friendly technologies through vermicomposting. In the past ten years these agencies in India have promoted farmers and institutions to swith from conventional chemicals to the organic fertilizers, vermicompost. Noted for its ablity to increase organic matter and trace minerals in soil, vermiculture has been the primary focus in India. The agencies which have initiated both commercial and educational ventures to promote vermiculture.

In 1985 a small plaant was established to manufacture vermicompost from agricultural waste. Those involved belived that a successful commercial venture based on regenerative principles might convince others to adapt sustainable practices. Farmers have reduced their use of chemical fertilizers by 90% by using vermicompost.

Vermicomposting and Vermiculture:

The various organic wastes including farm yard manure is fed by earth worms and they excrete out the fine mucus coated faecal pellets called vermicompost and the process is called vermicomposting. Vermiculture refers to culturing of earthworms for diverse purpose, major one being vermicomposting. Through the simple act of eating, earthworms promote bacterial growth, enhance soil structure and hasten the decomposition of organic matter. However, due to different feeding habits, not all earthworms are suitable for vermiculture. Earthworms are divided into groups: human farmers humus feeders. The first group dwells on the surface and feeds on nearly 90 percent fresh organic materials and 10 percent soil. They are generally red in colour, have a flat trail and are also called epegic or detritivorous worms and these worms are harnessed for vermicomposting. The second group, the humus feeders are deep burrowing worms that are useful in making the soil porous and mixing and distributing humus through the soil. The species of earthworms that are being used for vermicompost production are *Eisenia foetida, Eudrilus eugeniae, Perionyx excavatus, Lumbricus rubellus and Pheretima elongata*. Since the days of

great philosopher, Aristotle (4^{th} BC), earthworms have been reconized for their role in soil genesis and maintenance of its fertility. He called them as "intestines of the earth". They are responsible for breakdown of dead organic matter into plant nutrients. Earthworms, besides producing enormous amount of worm cast over the years, modify the structure of the soil and in its turnover. Exploitation of earthworms for biodegradation of organic wastes in a recent development in biological sciences (Graff, 1981), although the first scientific approach to study eartworms was made by great biologist Darwin in 19^{th} century (Darwin, 1881) in his classical publication, "the formation of vegetables mould through the action of worms, with observation on their habits". He described the role of earthworms in these words: "the plough is one of the most ancient and most valuable of man's inventions, but long before he existed, the land was infact regularly ploughed and still continuous to be thus ploughed by earthworms".

Vermicompost technology has promising potential to meet the organic manure requirement in both irrigated and rainfed areas. It has tremendous prospects in converting agro waste and city garbage into valuable agricultural input. When organic manures are used, the chemical nutrients are also utilized well by crops as they improve soil health and balance the nagative effects of chemicals. The prime market for vermicompost is in agriculture and horticulture. A large number of farmers are using vermicompost in large quantities. Small and marginal farmers would do well to produce vermicompost on their own. Home gardens, kitchen gardens and commercial plant nurseries are an excellent market for vermicompost in urben areas.

This enterprise offeres tremendous scope for expansion in rural areas because it has the potential to engage small farmers and women who can easily set up such units at the household level. The enterprises are based on the conversion of waste matter into rich plant humus by using earthworms. No specific skill is required. It is a viable production oriented enterprise with tremendous scope for expansion in rural areas.

The scope for production and use of vermicompost appers to be promissing in the country with the government laying much emphasis on the promotion of organic farming. In addition several non-governmental organizations (NGO's) have also been playing a vital role in spreading the message of organic farming. Potential for vermicomposting in Tamil Nadu vermicomposting is gaining strong foothold among the farmers of Tamil Nadu due to its multifunctional roles and benefits in agriculture. The advantages of vermicompost can be visualized in terms of improvement in soil physiochemical and biological propertise, improved rate of nutrient uptake by crops and yield recovery as reported by many studies. In several experiments, results have indicated that vermicomposting can substitute inorganic fertilizer requirements, results have

indicated that vermicomposting can substitute inorganic fertilizer requirement up to 50-75 percent.

Vermiculture can be adopted in two ways: by applying vermicompost at the rate of 2.5-5.0 Mt/ha at the time of sowing or in-situ vermiculture, where adequate organic waste has to be previously dumped. In Tamil Nadu, the players involved in vermicompost production activities are the farmers sector, government organizations, private organizations and other agencies. This has encouraged many government and non-government agencies to promote vermicompost production. Many enterprises by farmers and private agencies have shown keen interest in undertaking of vermicompost production. These prospective clearly shown that vermicompost could contribute enormously to farm production and economic conditions of rural people, besides being an eco-friendly activity. In recent years, concerted efforts have been initiated by the state as well as by private sector including many NGOs to create awarness amng farming community about need for application of suitable soil smmenments mainly in the form of organic matter for sustainable agricultural production. In this direction, vermicompost is an important source of organic matter to the soil as well as soil ammenment due to its multifunctional roles and benefits.

Steps in waste management:

Suramangalam Uzhavarsanthai in Salem district was started on 21.12.1999. It is one of the viable uzhavarsanthai amoung 11uzhavarsanthai in Salem district. The waste generatedin this uzhavarsanthai is composed by vermicomposting. The physico-chemical analysis of partial decomposed uzhalavarsandhai waste and vermicompost, nutrient availability in the partial decomposed uzhalavar sandhai waste and vermicompost, production cost of vermicompost from uzhalavarsandhai wastar, benefit cost ratio of vermicompost production from uzhalavarsandhai waste is analysed.

Three tracters full of uzhalavar sandhai waste were collected from suramangalam uzhalavar sandhiai which is weighted about 2500 kgs (wet weight). These wastes are transported to Mr.ganesan farmer’s field jagir ammapalayam village, Salem which was 3 kilometer away from suramangalam uzhalavar sandhai. These uzhalavar sandhai wastes were converted to vermicompost by using the following steps.

Step 1: Processing which are involved in collection of uzhalavar sandhai wastes, shredding, Mechanical seperation of the metals, glasses and ceramics draying of waste in open sunlight and storage of organic wastes.

Step 2: Pre digestion of uzhalavar sandhai waste for twenty days by heaping the material along with cattle dung slurry. This process partially digests the material and fit for earthworm consumption.

Step 3: Preparation of earthworm bed. A concrete base is required to put the waste for vermicompost preparation. Loose soil will allow the worms to go into soil and also while watering all the available nutrients go into the soil along with water. Finally 2 kgs of earthworms was introduced into the bed for feeding.

Step 4: Collection of earthworm after vermicompost collection (Approximately) 35 days after the introduction of worms into the bed). Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.

Step 5: Storing vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

Influence of pH, electrical conductivity and organic carbon (%):

The pH values of partial decomposed Uzhalavar sandhai waste and vermicompost are almost same. pH is neutral in nature. The electrical conductivity of partial decomposed uzhalavar sandhai waste is 1.52 dSm-1 and in vermicompost the EC is reduced to 0.55 dSm-1 due to vermicomposting. The percentage of organic carbon in partial decomposed uzhalavar sandhai waste is 13.03% and it is increased to 13.42% in vermicompost due to vermicomposting (Table 2).

Table 2: Physico-chemical charecteristics of vermicompost and uzhalavarsandhai waste

Sample ID	Details	pH	EC dsm^{-1}	N (%)	P (%)	K (%)	OC (%)	CN Ratio
I	Partially decomposed Uzhalavarsandhai waste	7.56	1.52	0.44	0.25	0.49	13.03	30:1
II	Vermicompost	7.60	0.55	0.92	0.64	0.88	13.42	15:1

Macro nutrients content:

The available nitrogen content of partial decomposed uzhalavarsandhai waste is 0.44% and in vermicompost 0.92%, available phosphorus content of partial decomposed

uzhalavarsandhai waste is 0.25% and in vermicompost 0.64% and in available potassium content of partial decomposed uzhalavarsandhai waste is 0.49% and in vermicompost 0.88%. So, the available N,P and K content is increased due to vermicomposting. Shweta and Mamta Sharma (2003) studied biomass and vermicompost production by the earthworm *Lampito mauritii*, in different organic wastes. Vermicompost was prepared from different substracts like kitchen waste, cow dung, buffalo dung, leaf litter, oil cake and agricultural waste individually or in combination utilizing indigenous earthworm, lampito mauritii. The increase in biomass (in number and weight) of earthworms was recorded and cow dung had the least number of earthworms with the maximum increase in weight. The reverse trend was observed in the leaf litter. The optimum increase in both number and weight was observed in the mixed substrate with dung.

Secondary nutrients content:

The calcium and magnesium content of partial decomposed uzhalavar sandhai waste is 22.4 mg/kg and 22.56 mg/kg. But in vermicompost the calcium and magnesium content is reduced to 20.6 mg/kg and 20.4 mg/kg due to vermicomposting.

Micro nutrients contents:

All the micronutrients content of partial decomposed uzhalavarsandhai waste is increased considerably due to vermicomposting. Copper content is from 0.68 ppm to 0.86 ppm, Zinc content is from 4.96 ppm to 6.47 ppm. Ferrous content is from 25.24 ppm to 28.48 ppm and the manganese content is from 26.08 ppm to 28.13 ppm. Mitchell and Edwards (1997) studied production of *Eisnia foetida* and vermicompost from feed-lot cattle manure. Significant reductions in total mass of feedlot cattle manure were obtained by the intensive activity of earthworms. The process yielded two products:residual vermicompost, and an increase in earthworm biomass. Different modes of manure application were made to a prepared bedding (or support material), the most sucessful being a surface (vertical) application which resulted in a reduction of 30% of the initial manure (dry) mass and the production of live earthworm to 4.9% of the intial manure mass (dry weight). The increase in earthworm biomass represented extraction of 7, 18, 7 and 2% of intial total C,N,S and perspectively from the manure.

Carbon Nitrogen Ratio:

The carbon Nitrogon Ratio (CN Ratio) of partial decomposed uzhalavarsandhai waste is 30:1 and it is considerably reduced to 15:1 in vermicompost due to vermicomposting.

Production cost of vermicompost from uzhalavarsandhai waste:

The cost incurred in production of one ton of vermicompost is Rs.2526/-. It can be seen that the total variable cost which primarily comprised the material cost accounted for 73.29% of

total cost. Material cost which arose on account of transport cost of wastes obtained from uzhalavarsandhai, procurment of cow dung and earthwarms.

Table 3: Production cost of vermicompost (Heap Method) Unit. (Rs./ ton)

S.No	Particulars	Units	Physical quantity	Value (Rs.)
	Variable costs			
I	**Material costs**			
1	Transport cost of Uzhalavarsanthai wastes	Tons	2.5	1200.00
2	Cow dung	Kgs	100	50.00
3	Earthworms	Kgs	2.0	600.00
	TOTAL	Rs.		**1850.00** (73.29)*
II	**Labour costs**			
1	Segregation of uzhalavar waste and partial decomposition of waste	MD	1.0	250.00
2	Bedding	MD	0.5	125.00
3	Watering	MD	0.5	125.00
4	Collection of worms and sieving	MD	0.5	125.00
	TOTAL	Rs.		**625.00** (24.74)*
III	**Interest on working capital**	Rs.	8.25%	**51.00** (1.97)*
IV	**Total variable costs (I+II+III)**	Rs.		**2526.00** (93.69)**
	Fixed costs			
1	Land rent	Rs.		50.00
2	Working shed	Rs.		70.00
3	Tools and machineries	Rs.		50.00
V	**Total Fixed costs**	Rs.		**170.00** (6.31)**
VI	**Total production costs (IV + V)**	Rs.		**2696.00**

Labour cost which accounted for around 24.74% of the total variable cost. The labour cost incurred for segregation of uzhalavarsandhai waste, partial decompostion of waste, bedding, watering and collection of worms and for sieving. Interest on working capital accounted for around 1.97% of the total variable cost. Total fixed cost which amounted to around Rs. 170/- per ton accounted for around 6.31% of total cost of production. The components of the fixed cost were land rent, working shed charges and cost associated with the use of tools and machineries. Overall, the total cost for the production of one ton of vermicompost is Rs. 2696/- from 2.5 metric tonnes of uzhalavarsandhai waste (Table 3).

Cost around returns from production and sale of vermicompost:

The total cost including production cost and marketing cost for one metric ton of vermicompst is Rs. 3016/-. The price realized per metric ton is 5000/- and returns per metric ton is 1984/-. (Table 4)

Table 4: Costs and returns from production and sale of vermicompost

S.No	Particulars	Qty	Heap method
A	**Production cost (A)**	**1 MT**	**2696.00**
B	**Marketing cost**		
I	Cost of once used plastic bags	80 bags	240.00
Ii	Packing charges	80 bags	80.00
	Total (B)		**320.00**
	Total Cost (A+B)		**3016.00**
C	Price realised per ton		5000.00
	Net returns per C-(A+B)		**1984.00**

Cost benefit Ratio:

The cost benefit ratio of one metric ton of vermicompost from 2.5 metric ton of uzhalavarsandhai waste is 1:1:66 (Table 5).

Table 5: Benefit Cost Ratio

S.No	Particulars	Qty	Heap method
A	**Production and Marketing cost of vermicompost**	**1 MT**	**3016.00**
B	Price realised per ton	1 MT	5000.00
	Cost Benefit Ratio	**1 MT**	**1:1:66**

Conclusion:

The price per metric ton is 5000/. And the net return per metric ton is 1984/-. The benefit cost rationof one metric ton of vermicompost of uzhavarsandhai waste is 1:1.66. It is evident from the present study Vermicomposting is a better option to manage the Uzhavarsandhai waste and also to improve soil health with good nutrition content.

References:

Athani, S. I., and Hulamani, N. C., 2000, Effect of vermicompost on fruit yield and quality of babana cv. Rajapuri. Kar. J. Agric. Sci., 13(4):942-946.

Baghel, S. S., Agrawal, S.B., and Archna Pandey, 2005, vermicompost production technology:adoption, advantages and problems encountered by adoptors, JNKVV Res. J., 39(2): 125-126.

Barik, T., Panda, R.K., Dash, S., Nayak, M.P., and Sontakke, B., 2005, Effect of different farm wastes on vermicomposting. J. Applied Zoological Researchers, 16(1):106-107.

Biradar, A.P., and Shaila, H.M., 2006, studies on suitability of vermipits for vermicomposting Kar. J. Agric. Sci., 19(2):411-413.

Biradar, A.P., Nandihalli, B. S., Guled, M.B., Jagginavar, S.B., 2001, Influence of Vermiculturing structureson the biomass of Eudrilus eugeniae (Kinberg) and Vermicompost production. Kar. J. Agric. Sci., 14(2):349-352.

Chinnappa Reddy, B.V., Subba Reddy, P.N., and Kale, R.D., 2007, Economic impact and production efficiency of vermicompost use in agriculture: methodological approaches, Agric. College, University of Agric. Sci., VC Farm, Mandya.

Gauri, P,V, S, M., 2005, National Programme for Organic Production. In Proceedings: National Seminar on National Policy on Promoting Organic Farming, Ghaziabad (India): National Centre of Organic Farming. 44-48 pp.

George, S., and Pillai, G.R., 2000, Effect of vermicompost on yield and economics of guinea grass grown as an intercrop in coconut gardens. Ind. J. Agronomy, 45(4):693-697.

Giraddi, R.S., 2000, Influence of vermicomposting methods and season on the biodegradation of organic wastes. Ind. J. of Agric. Sci., 70(10):663-666.http://agritech.tnau.ac.in/org_farm/orgfarm_index.html

Mitchell, A., and Edwards, C.A., 1997, Production of Eisenia fetida and vermicompost from feed-lot cattle manure. Soil Biol. And Biochem., 29(3/4): 763-766.

National Project on Organic Farming (NPOF), 2005, Organic farming newsletter 1(1):9-18.

Preetha, D., Sushma, P.K., and Marykutty, K.C., 2005, Vermicompost + Inorganic fertilizers promote yield and nutrient uptake of amarnath.J. of Tropical Agric., 43(1/2): 87-89.

Rajkhowa, D.J., Saikia, M., and Rajkhowa, K.M., 2003. Effect of vermicompost and levels of fertilizer on green gram. Legume Res., 26(1):63-65.

Shwetha. Mamta Sharma., 2003, Biomass and vermicompost production by the earthworm, Lampito maruti in different organic wastes. Journal of Applied Zoological Researches. 14(1): 98-100.

Shivakumara. C 2008 Dr. S.B. Mahajanashetti, Major Advisor – Production and Marketing of Vercomposting in Karnataka: A Case of Dharwad district.

Sunitha, N.D., Giraddi, R.S., Kulkarni, K.A., and Lingappa, S., 1997, Evaluation methods of vermicomposting under open field conditions. Kar. J. Agric. Sci., 10(4):987-990.

VEMICOMPOSTING OF *POLYALTHIA LONGIFOLIA* LEAVES USING *EUDRILUS EUGENIAE*

Sivasankari B*[1], Prema J.[1] and Ganesh S[2]

[1]Department of Biology,

The Gandhigram Rural Institute, (Deemed to be University), Gandhigram

[2]Department of Physics,

The Gandhigram Rural Institute, (Deemed to be University), Gandhigram

*Corresponding author E-mail: balayogansivasankari@gmail.com

Abstract:

The leaf waste was collected from surrounding area of Gandhigram rural institute (Deemed to be University), Gandhigram, Dindigul District, TamilNadu India. The earthworm species (*Eudrilus eugeniae*) was collected from S.S.Vermiform, Pandiyarajapuram, Vadipatti (TK), Madurai District, TamilNadu India.The leaf waste was predecomposed using cow dung in the ratio of 1:1 (1kg leaf waste +1kg cow dung). The leaf waste was allowed to predecomposition for 30 days. The physical parameters such as pH, electrical conductivity, temperature, nitrogen, phosphorus, potassium, organic carbon were analysed once in 15 days upto 60 days.

Keywords: *Polyalthia longifolia* leaves, *Eudrilus eugeniae*, vermicompost

Introduction:

Vermicomposting is a bio-oxidative process in which earthworms interact intensively with microorganisms and other fauna with in the decomposer community, acceleration the stabilization of organic matter and modifying its physical and bio chemical properties. The action of the earthworms in this process physical or mechanical, physical participation in degrading organic substrates results in fermentation, thereby increasing the surface area of action, turn over and aeration. On the other hand, bio chemical changes in the degradation of organic matter are carried out by microorganisms through enzymatic digestion, enrichment by nitrogen excrement and transport of inorganic and organic materials. *Polyalthia longifolia*, the false Asoka native to India, is a lofty evergreen tree, commonly planted due to its effectiveness in alleviating noise pollution. It exhibits symmetrical pyramid growth with willowy weeping pendulous branches and long narrow lance late leaves with undulate margins. The tree is known to grow over 30 ft in height. Fresh leaves are coppery brown colour and also soft and delicate to touch, as the leaves

grow older to the colour becomes a light green and finally a dark green. The leaves are shaped like a lance and have wavy edges. The leaves are larval food plant of the tailed pay and the kite swallowtail butteries Sannigrahi (2009), Satyendra and Singh (2013), Lakshmi Prabha and Senthamizh Selvan (2014), Sentil Kumari *et al.* (2013), Karmakar *et al.* (2013).

Materials and methods:

Collection of leaf sample:

Leaf waste was collected from surrounding area of Gandhigram Rural Institute Deemed to be University, Gandhigram, Dindigul (District), Tamilnadu India . The leaf picture was given plate1.

Plate 1: Leaf of *Polyalthia longifolia*

Collection of earthworm:

Earthworm species (*Eudrilus eugeniae*) was collected from SS Vermiform, Pandiyarajapuram, Vadipatti (TK), Madurai (District), Tamilnadu. The earthworm species (*Eudrilus eugeniae*) was given plate 2.

Plate 2: Earthworm *Eudrilus eugeniae*

Predecompostion of leaf waste:

The leaves were collected and shopped into small pieces. It was cured in the open to shade area for 15 days. Water was sprinkled on the waste twice in a day in order to hasten the predecomposing process. Plastic trays of 45x15x30 cm size were used. Predecomposition of leafs in tray was given in plate 3.

Plate 3: Predecomposition of leaf wastes

Preparation of vermibed:

The vermibeds were prepared by mixing the processed mixed leaf litter with cured cow dung in 1:1(1 kg of pre decomposed leaf and 1 kg of cow dung) ratio. After 15 days of pre-decomposition of leaf wastes.

Inoculation of earthworm:

The 15 clitellate *Eudrilus eugeniae* adult earthworms were inoculated into each of these trays. The earthworms entered into the media immediately after the inoculation except in the control tray. These trays were kept undisturbed in shades. Watering was done regularly twice in a day in order to maintain the temperature and moisture content of the medium during the entire composting period was 60 days.

Physicochemical analysis of vermicompost:

The vermicomposting was carried out in an environmentally controlled experimental chamber were temperature of 27±1^{o}c and the vermibeds were maintained to contain a moisture level of 70-80%. Various physiochemical parameters such as pH, electrical conductivity, and total nitrogen (%), total phosphorus (%), total potassium (%) and organic carbon were analysed using the standard methods.

Result and Discussion:

Most of the leaf wastes when subjected to feeding by earthworm microorganisms also involved and then it converted into blackish powdery form called vermicompost. In present investigation leaf litter of *Polyalthia longifolia* was used as organic substrate separately with cow dung in 50:50 ratios. During vermicomposting physiochemical parameters were also measured and results are given in table 1 and figure 1.

Table 1: physicochemical parameters analyzed on 1st,15th, 30th , 45th ,60th days

Days	pH	Temp. (^{0}C)	Ec (ds/m)	C (%)	N (%)	P (%)	K (%)
1st	7.6	27°c	1.4(ds/m)	39.06%	2.10%	0.54%	2.17%
15th	7.9	29°c	1.9(ds/m)	23.02%	2.3%	0.65%	1.46%
30th	7.3	28°c	1.8(ds/m)	22.72%	2.5%	1.62%	2.07%
45th	7.5	29°c	2.5(ds/m)	20.35%	1.64%	1.52%	1.67%
60th	7.2	28°c	2.9(ds/m)	19.00%	1.56%	1.06%	1.97%

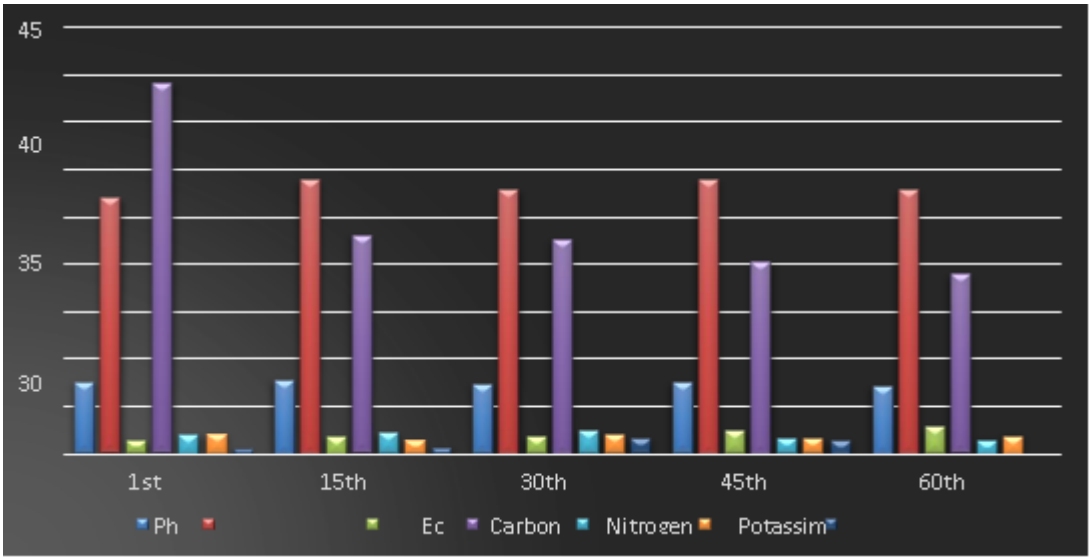


Figure 1: physicochemical parameters analyzed on 1st, 15th, 30th , 45th ,60th days

Similar results during vermicomposting of cow manure such as pH (6.92), electrical conductivity (1.83 ds/m), Moisture content (70.14%), total organic carbon (42.3), total nitrogen (1.66%), total phosphorous (0.91%), total potassium (2.78%) was observed by Prakash *et al.* (2008). Jeyanthi *et al.* (2014) reported the vermicompost of cow manure and their physico chemical parameters such as pH value was (7.0) total organic carbon (14.83), total nitrogen

(1.39), total phosphorous (5.87), total potassium (4.56). Chhotu *et al.* (2008), reported that the vermicomposting of cow manure its physico chemical parameters such as pH was (7.2), temperature was (32.5), total organic carbon was (19.00), total nitrogen was (1.06), moisture content was (74.30), electrical conductivity was (7.75). Physicochemical parameters of vermicompost such as pH (7.4), total organic carbon (21.5), total nitrogen (0.90), total phosphorous (0.45), total potassium (0.5) showed similar results reported in he study carried out by Sakthivel *et al.* (2018).

References:

Chhotu D.Jarda., Fluekear, M.H., (2008).Vermicomposting of vegetable wastes:A bio-physico chemical process based on hudro operating bioreactor.African Journal of Biotechnology.7(20):3723-3730.

Jayanthi, B. (2014).Vermicomposting of couroupita guianensis by using two epigeic earthworms *Eudrilus eugeniae* and *Eisenia fetida*. Golden Research Thoughts.4(4).S

Lakshmi Prabha, M., and Senthamizh Selvan, T (2014).Nutrient analysis of *Polyalthialongifolia* (leaf litter) degraded by *Eudrilus eugenia*e. International Journal of Chem TechResearch, 6 (1): 334-348.

Prakash,M., Jayakumar,M., Karmegam,N.,(2008).Physico –chemical characteristics and fungal flora in the casts of the Earthworm,Perionyx ceylanensis Mich.Reared in *Polyyalthia longifolia* leaf litter.Journal of Applied Science Research.4(1),53-57.

Sakthivel vellaikannu.,Rajeshwari,Duraikumar.,Vinoth Mohan ., Saralabai Viswanathan Chathingathe, (2018). Vermicomposting of saw dust mixed with cow dung using *Eudrilus eugeniae,* International Journal of Biology Research, Vol 3, PP 30-32.

Sannigrahi, A.K (2009). Biodegradation of leaf litter of tree species in presence of cow dungand earthworms. Indian Journal of Biotechnology, 8:335-338.

Satyendra M. Singh (2013). Suitability of tough Asiatic grass for vermicomposting. Indian Journal of Weed Science, 45 (1) : 55-57.

Sentil Kumari, M., Vasanthi, K., Saradha, T., and Bharath, R (2013). Studies on the vermiconversion of different leaf wastes by using *Eudrilus eugeniae*, International Journal ofAdvance Research, 1 (3):96-101.

Sruti Karmakar., Koushik Brahmachari and Aniruddha Gango Padhyay (2013). Studies on agricultural waste management through preparation and utilization of organic manures for maintaining soil quality. African Journal of Agricultural Research, 8 (48): 6351-6358.

RELATIVE DIVERSITY AND SIMPSON DIVERSITY INDEX OF AVIFAUNA FROM INDORE CITY (M.P.)

Priya Gaur

Institute of Biosciences, Sage University Indore (M.P.), INDIA

Department of Zoology, Government Holkar Science College Indore, (M.P.), INDIA

Corresponding author E-mail: priyagaur9406@gmail.com

Abstract:

Indore city has a lush green milieu of vegetation. The aim of this study is evaluating the Relative Diversity and Simpson's Index of the recorded avian fauna within the city. Regular visits were made in morning and evening at each site in each season (2018). Birds and trees were photographed for identification. Family Muscicapidae with RD of 14.29 in the winter season at Lalbagh was the highest recorded value in the present study and family Columbidae with 8.33 was the lowest value of Relative Diversity in the summer season of Meghdoot Garden. The highest value of Simpson's index (D) (i.e. 0.0935) was recorded at Nehru Park in summer and lowest was at Regional park in summer season (0.0681). Though, there are various measures already taken up by the governing body for the salvation of these green spaces (for vegetation only). Through this study the author would like to draw the attention toward the existing avifaunal diversity in these green spaces.

Keywords: Indore, Relative Diversity, Simpson, Species Diversity, Vegetation

Introduction:

Conservational methods involve interspersing methodology of pest control rather than chemicals like pesticides. A collaboration of government and non-government organizations must be done to enrich fauna of the area. Awareness plays a vital role in making local people and tourists sensitive towards these issues (Kushwaha *et al.*, 2015). Similarly, activities like tourism pressure, habitat fragmentation, less water availability in the dry season and habitat destruction are physical pressures which are imparting risk to avian fauna. Conservation in open areas can be done by avoiding trampling by the visitors' dogs and wild cattle especially during the breeding season (Chopra *et al.,* 2012). Occasional fires and pruning make shrubs and trees look good decorative and their growth is also enhanced. But these exercises destroy some of the nests of species like Ashy prinia, as they make their nest in short bushes. These are exertions for birds

during the nesting period. Education of local authorities is necessary for the repucurtions and loss of avian diversity (Pasha *et al.,* 2004).

There is a correlation between the number of trees and avian fauna recorded in a particular area (Sahni 2000). To sum up, Indore city consists of a favourable environment for avian fauna to survive in this area as selected sites are densely covered by vegetation. *Azadirachta indica, Ziziphus mauritiana, Schleichera oleosa, Anacardium occidentale, Mangifera indica, Moringa oleifera, Acacia nilotica, Cassia fistula, Tamarindus indica, Butea monosperma, Syzygium cumini, Ficus benghalensis, Ficus religiosa* and *Phoenix dactylifera* are some of the dominant vegetation in these sites. Though, various ornithologists have reported many species from different areas of Madhya Pradesh but, Meghdoot Garden, Nehru Park and Lalbagh have no previous literature on these two indexes. This study deals with the estimation of Relative Diversity and Simpson's Index of the recorded avian fauna.

Methodology:

Study area:

Indore city of district Indore (M.P.) was selected for studying and evaluating the Relative Diversity and Simpson's Index. All the selected sites are maintained by the IDA (Indore Development Authority). These sites have rich mosaic vegetation and have become a preferred area by locals for recreational activities like jogging, yoga and morning walk. Prepaid passes are being issued by local authorities, so these greenspaces generate revenue. Selected areas are Meghdoot Garden, Nehru Park, Lalbagh and Pipliyapala Regional Park.

Study Period:

The study was done for a period of 12 months i.e. January 2018 to December 2018. The study was divided into three seasons i.e. winter season, summer season and rainy season. These categories were made with the help of Meteorological Data. Thus, during winters average minimum temperature recorded was 12.85°C (Degree Celsius) and Maximum average temperature was 31.07°C. While in the summer season, average minimum temperature was 19.95 °C and Maximum average temperature was 38.27 °C. Lastly, in the rainy season, the numbers of rainy days were 38 with 756.70mm rainfall. The average minimum temperature was 23.74°C and Maximum average temperature was 32.46 °C. The highest and lowest temperatures recorded in the year 2018 were 44.36 °C and 7.40 °C respectively.

Figure 1: Images of selected Sites (A- Meghdoot Garden, B- Nehru Park, C- Lalbagh and D- Pipliyapala Regional Park)

Survey Methodology:

Regular visits were made in the morning and evenings at each site in each season. Birds were photographed for identification. The checklist was prepared by Raju and Ramachandran (2016).

Data Analysis:

Initially a checklist of avian fauna was prepared at all the sites (by Gaur *et al.*, 2019). The Relative Diversity was calculated by Datta (2016)

$$\text{RD/PC} = \frac{\text{Number of species of each family}}{\text{Total number of different species seen}} \times 100$$

Simpson's diversity indices were calculated by Magurran (2004) with the help of following

Formula: $D = \frac{\sum n(n-1)}{N(N-1)}$

Results:

In the present study, Relative Diversity (RD) and Simpson's diversity indices were calculated for the recorded avian fauna at all the four sites of Indore City. The values of relative diversity showed in Meghdoot Garden in the winter season; family Columbidae was dominant with three species and a value of 8.57 in this season. In the summer season, thirty-six species belonging to twenty-eight families were observed with family Columbidae to be dominant (RD 8.33). Similarly, thirty-five species of twenty-seven families were listed in the rainy season and family Columbidae was found to be dominant (RD 8.57). Simpson's index in all three seasons was 0.0794 (winter), 0.0877 (summer) and 0.082 (rainy) (Table – 1&2). The highest Simpson's index of diversity was seen in the winter season of Meghdoot Garden.

At Nehru Park, family Columbidae, Corvidae and Muscicapidae (with three species each) were found to be dominant (RD 10) in the winter season. In the summer season, thirty species of twenty-five families were reported out of which family Muscicapidae was dominant having an RD of 12.12. In the rainy season, thirty-one species of twenty-four families were observed. Family Muscicapidae, Corvidae and Columbidae were found to be dominant (RD 9.68) (Table – 2). Similarly, Simpson's index in Nehru Park for three seasons were 0.0877 (winter), 0.0935 (summer) and 0.093 (rainy). The highest Simpson's index of diversity was seen in the winter season at this site (Table – 1).

At Lalbagh, in the winter season family Muscicapidae was dominant with five species and an RD value of 14.29. In the summer season, thirty-nine species belonging to twenty-six families were observed with family Muscicapidae to be dominant (RD 12.82). Similarly, thirty-

four species of twenty-three families were listed in the rainy season and family Muscicapidae was found to be dominant (RD 11.76) (Table 2). The Simpson's index in the winter season was 0.0756; 0.0809 in summer and 0.0806 in the rainy season. The highest Simpson's index of diversity was seen in the winter season of Lalbagh (Table – 1).

At Pipliyapala Regional Park, family Muscicapidae (with five species) was found to be dominant with an RD of 11.62 in the winter season. In the summer season, fifty-two species of thirty-one families were reported out of which family Muscicapidae was having an RD of 11.54. In the rainy season, forty-six species of twenty-nine families were observed. Family Muscicapidae was found to be dominantwith RD of 10.87. Similarly, Simpson's index in Pipliyapala Regional Park for three seasons were 0.0687 (winter), 0.0681 (summer) and 0.0689 (rainy) respectively. The highest Simpson's index of diversity was seen in the summer season at this site (Table – 1).

Hence, the highest number of families was recorded in the summer season at Regional Park i.e. thirty-one and the lowest families were observed in the winter season of Lalbagh and Nehru Park i.e. twenty-three each.

Family Muscicapidae with RD of 14.29 in the winter season at Lalbagh is the highest recorded value and family Columbidae with 8.33 is the lowest value of Relative Diversity in the summer season of Meghdoot Garden. The highest value of Simpson's index (D) (i.e. 0.0935) was recorded at Nehru Park in summer and lowest was at Regional park in summer season (0.0681). Simpson's index of Diversity (1 – D) was seen in Regional Park i.e. 0.9319 and least in 0.905 at Nehru Park both in summer seasons. The highest value of Simpson's Reciprocal Index (1/D) was 14.6843 at Regional Park and lowest at 10.6952 at Nehru Park both in summer seasons.

Table 1: Simpson's Diversity Indices

Site/Season	Winter			Summer			Rainy		
	D	**1-D**	**1/D**	**D**	**1-D**	**1/D**	**D**	**1-D**	**1/D**
Meghdoot	0.0794	0.9206	12.5945	0.0877	0.9123	11.4025	0.0820	0.9180	12.1951
Nehru	0.0877	0.9123	11.4025	0.0935	0.9065	10.6952	0.0930	0.9070	10.7527
Lalbagh	0.0756	0.9244	13.2275	0.0809	0.9191	12.3609	0.0806	0.9194	12.4069
Regional	0.0687	0.9313	14.5560	0.0681	0.9319	14.6843	0.0689	0.9311	14.5138

(D=Simpson's Index; 1-D= Simpson's Index of Diversity and 1/D =Simpson's Reciprocal Index)

Table 2: Checklist of birds showing its order and families at different sites of Indore City

	English Name	*Scientific Name*	Order	Family	MG	NP	LB	RP	W	S	R
1	Indian Peafowl	*Pavo cristatus*	Galliformes	Phasianidae	A	A	A	RP	A	A	■
2	Rock Pigeon	*Columba livia*	Columbiformes	Columbidae	MG	NP	LB	RP	▲	●	■
3	Spotted Dove	*Streptopelia chinensis*	Columbiformes	Columbidae	MG	NP	LB	RP	▲	●	■
4	Laughing Dove	*Streptopelia senegalensis*	Columbiformes	Columbidae	MG	NP	LB	RP	▲	●	■
5	Indian House Swift	*Apus affinis*	Caprimulgiformes	Apodidae	A	NP	LB	RP	▲	●	■
6	Greater Coucal	*Centropus sinensis*	Cuculiformes	Cuculidae	MG	A	LB	RP	▲	●	■
7	Pied Cuckoo	*Clamator jacobinus*	Cuculiformes	Cuculidae	A	A	A	RP	▲	●	A
8	Asian Koel	*Eudynamys scolopaceus*	Cuculiformes	Cuculidae	MG	NP	LB	RP	▲	●	■
9	Indian Pond Heron	*Ardeola grayii*	Pelecaniformes	Ardeidae	A	A	A	RP	▲	●	■
10	Cattle Egret	*Bubulcus ibis*	Pelecaniformes	Ardeidae	MG	NP	A	RP	▲	●	■
11	Red - wattled Lapwing	*Vanellus indicus*	Charadriiformes	Charadriidae	MG	NP	LB	RP	▲	●	■
12	Black - winged Kite	*Elanus caeruleus*	Accipitriformes	Accipitridae	A	A	LB	RP	A	A	■
13	Oriental Honey Buzzard	*Pernis ptilorhynchus*	Accipitriformes	Accipitridae	A	A	A	RP	A	A	■
14	Shikra	*Accipiter badius*	Accipitriformes	Accipitridae	MG	NP	A	RP	▲	●	■
15	Black Kite	*Milvus migrans*	Accipitriformes	Accipitridae	MG	NP	LB	RP	▲	●	■
16	Spotted Owlet	*Athene brama*	Strigiformes	Strigidae	MG	NP	LB	RP	▲	●	■
17	Indian Grey Hornbill	*Ocyceros birostris*	Bucerotiformes	Bucerotidae	MG	NP	LB	RP	▲	●	■
18	Coppersmith Barbet	*Psilopogon haemacephalus*	Piciformes	Megalaimidae	MG	NP	LB	RP	▲	●	■
19	Green Bee - eater	*Merops orientalis*	Coraciiformes	Meropidae	MG	NP	LB	RP	▲	A	A

20	White - throated Kingfisher	*Halcyon smyrnensis*	Coraciiformes	Alcedinidae	MG	NP	LB	RP	▲	●	▉
21	Plum - headed Parakeet	*Psittacula cyanocephala*	Psittaciformes	Psittaculidae	A	A	A	RP	A	●	▉
22	Alexandrine Parakeet	*Psittacula eupatria*	Psittaciformes	Psittaculidae	MG	A	A	RP	▲	A	▉
23	Rose - ringed Parakeet	*Psittacula krameri*	Psittaciformes	Psittaculidae	MG	NP	LB	RP	▲	●	▉
24	Small Minivet	*Pericrocotus cinnamomeus*	Passeriformes	Campephagidae	MG	A	LB	RP	▲	●	▉
25	Large Cuckooshrike	*Coracina javensis*	Passeriformes	Campephagidae	A	A	LB	RP	A	●	A
26	Indian Golden Oriole	*Oriolus kundoo*	Passeriformes	Oriolidae	A	NP	LB	RP	A	●	A
27	Common Iora	*Aegithina tiphia*	Passeriformes	Aegithinidae	MG	NP	LB	RP	▲	●	▉
28	Black Drongo	*Dicrurus macrocercus*	Passeriformes	Dicruridae	MG	NP	LB	RP	▲	●	▉
29	White - throated Fantail	*Rhipidura albicollis*	Passeriformes	Rhipiduridae	MG	NP	A	RP	▲	●	▉
30	Rufous Treepie	*Dendrocitta vagabunda*	Passeriformes	Corvidae	MG	NP	LB	RP	▲	●	▉
31	House Crow	*Corvus splendens*	Passeriformes	Corvidae	MG	NP	LB	RP	▲	●	▉
32	Large - billed Crow	*Corvus macrorhynchos*	Passeriformes	Corvidae	A	NP	LB	RP	▲	●	▉
33	Indian Paradise - flycatcher	*Terpsiphone paradisi*	Passeriformes	Monarchidae	MG	A	A	RP	A	●	A
34	Thick - billed Flowerpecker	*Dicaeum agile*	Passeriformes	Dicaeidae	MG	NP	A	RP	A	●	▉
35	Purple - rumped Sunbird	*Leptocoma zeylonica*	Passeriformes	Nectariniidae	A	NP	A	RP	A	●	▉
36	Purple Sunbird	*Cinnyris asiaticus*	Passeriformes	Nectariniidae	MG	A	LB	RP	▲	●	▉
37	Indian Silverbill	*Euodice malabarica*	Passeriformes	Estrildidae	MG	A	LB	RP	▲	●	▉
38	House Sparrow	*Passer domesticus*	Passeriformes	Passeridae	MG	NP	LB	RP	▲	●	▉
39	White - browed Wagtail	*Motacilla maderaspatensis*	Passeriformes	Motacillidae	A	A	LB	RP	A	●	A
40	White Wagtail	*Motacilla alba*	Passeriformes	Motacillidae	A	A	A	RP	A	●	A
41	Black - lored Tit	*Machlolophus xanthogenys*	Passeriformes	Paridae	MG	A	A	RP	A	A	▉

42	Ashy Prinia	*Prinia socialis*	Passeriformes	Cisticolidae	A	A	LB	RP	▲	●	▉
43	Common Tailorbird	*Orthotomus sutorius*	Passeriformes	Cisticolidae	MG	NP	LB	RP	▲	●	▉
44	Wire - tailed Swallow	*Hirundo smithii*	Passeriformes	Hirundinidae	A	A	LB	RP	A	●	A
45	Barn Swallow	*Hirundo rustica*	Passeriformes	Hirundinidae	MG	A	LB	RP	A	●	A
46	Dusky Crag Martin	*Ptyonoprogne concolor*	Passeriformes	Hirundinidae	MG	NP	A	RP	▲	●	▉
47	Red - vented Bulbul	*Pycnonotus cafer*	Passeriformes	Pycnonotidae	MG	NP	LB	RP	▲	●	▉
48	Greenish Leaf Warbler	*Phylloscopus trochiloides*	Passeriformes	Phylloscopidae	MG	A	A	RP	▲	●	A
49	Oriental White - eye	*Zosterops palpebrosus*	Passeriformes	Zosteropidae	MG	A	LB	RP	▲	●	▉
50	Jungle Babbler	*Turdoides striata*	Passeriformes	Leiothrichidae	MG	NP	LB	RP	▲	●	▉
51	Asian Pied Starling	*Gracupica contra*	Passeriformes	Sturnidae	MG	A	LB	RP	▲	●	▉
52	Common Myna	*Acridotheres tristis*	Passeriformes	Sturnidae	MG	NP	LB	RP	▲	●	▉
53	Indian Robin	*Saxicoloides fulicatus*	Passeriformes	Muscicapidae	MG	NP	LB	RP	▲	●	▉
54	Oriental Magpie Robin	*Copsychus saularis*	Passeriformes	Muscicapidae	MG	NP	LB	RP	▲	●	▉
55	Tickell's Blue Flycatcher	*Cyornis tickelliae*	Passeriformes	Muscicapidae	A	A	LB	RP	▲	●	▉
56	Red - breasted Flycatcher	*Ficedula parva*	Passeriformes	Muscicapidae	A	NP	LB	RP	▲	●	▉
57	Siberian Stonechat	*Saxicola maurus*	Passeriformes	Muscicapidae	A	NP	A	RP	A	●	A
58	Brown Rock Chat	*Oenanthe fusca*	Passeriformes	Muscicapidae	A	A	LB	RP	▲	●	A

("MG" represents bird species presence in study site 1; "NP" represents bird species presence in study site 2; "LB" represents bird species presence in study site 3; "RP" represents bird species presence in study site 4; "▲" represents that the species were present in Winter Season; "●" represents that the species were present in Summer Season and "▉" represents that the species were present in Rainy Season and A represent species absence)

Discussion:

The results of Meghdoot Garden showed that the highest Relative Diversity (RD) was observed for Family Columbidae (three species) with value 7.69. In contrast to these results, Kumar and Gupta (2009) calculated per cent occurrence of the avian fauna in their study site. The highest value recorded was 20.37% (RD) of Family Anatidae. Furthermore, in Nehru Park, the highest Relative Diversity (RD) was recorded for Family Muscicapidae (four species) with a value of 11.76. Similarly, Lodhi *et al.* (2018) observed the avifaunal diversity in Gwalior region and concluded that the Family Scolopacidae was dominant with six species (highest Relative diversity). Another worker like James *et al.* (2017) adopted a similar methodology to estimate relative abundance (RA) but that too was species wise. Several attempts are made by researchers to find species diversity through Simpson's (D) diversity indices; Vallejo *et al.* (2009) estimated Simpson's index of Dominance (D) in eight study sites and reported the highest value of 7.30 and lowest of 2.34 in their study sites. They have also stressed upon including urban greenspaces in the planning of cities in the near future so that it can enhance species diversity hereafter.

In addition to this, in Lalbagh, the highest Relative Diversity (RD) was observed for Family Muscicapidae (five species) with value 12.19. Issa (2019) also mentioned various indices for evaluating bird diversity in their area. But they have calculated Relative abundance (RD) species wise; which is quite contrasting to our study because we have estimated the relative diversity family-wise.

And lastly, in Pipliyapala Regional Park, the highest Relative Diversity (RD) was observed for Family Muscicapidae (six species) with value 10.34. Similarly, Shekhawat and Bhatnagar (2014) reported 101 species belonging to 34 families out of which family Accipitridaewas dominant with a value of 10.89 (R. D.) and followed by family Muscicapidae with 7 species (RD= 6.93). However, a study conducted in Govt. Holkar Science College Indore revealed that family Muscicapidae was dominant with an RD value of 13.7 with 6 families in its category (Bhonsle *et al.,* 2018). However, our study corroborates with the above-mentioned authors. These green spaces need to be conserved for the sustentation of these recorded species.

Conclusion:

Thus, it is evident that the Indore city is perfect amalgamation of various types of vegetation. This environment sustains various species of birds. The authority takes sufficient care of these areas and also have fund for growing more flowering plants hereafter. Grains like wheat, Bajri (Pearl millet) and Jowar (sorghum) are regularly disbursed by security guards in the study area. Local authorities ensure that there is a permanent water supply for the whole year for

maintaining greenery. Relative diversity was calculated to calculate the family contribution to the total diversity recorded. As we can apprehend that this study is crucial in highlighting the importance of these green spaces in the city. The above result pinnacles the use of these indices in estimating the different aspects of Diversity.

Acknowledgement:

The author is very grateful to Dr. Santosh Gaherwal, Govt. Holkar Science College, Indore (M.P.) and Mr. Osho Rao Bhonsle for their immense help and support for conducting this study. Author acknowledge the help received from and other scholars whose articles are cited and included in references of this manuscript. The author is also grateful to authors / editors / publishers of all those articles, journals and books from which the literature for this article has been reviewed and discussed.

References:

Bhonsle, O.; Shrivastava, C.S.; Jain, R. and Gaherwal, S. (2018). A Preliminary Study on Avian Fauna at Govt. (Model, autonomous) Holkar Science College, Indore (M.P.). International Journal of Scientific Research in Biological Sciences, 5(1):18-27.

Chopra, G.; Tyor, A.K.; Kumari, S. and Raj, D.(2012). Status and conservation of avian fauna of Sultanpur National Park Gurgaon, Haryana (India). Journal of applied and natural sciences, 4(2): 207-213.

Datta, M. (2016). Status, guild and diversity of avian fauna from wetland site and surroundings, in Krishnagar, a City beside tropic of cancer, West Bengal, India. International Journal of Fauna and Biological Studies,4:68-75.

Gaur, P.; Shrivastava, C.S. and Gaherwal, S. (2019). Spatial Variation in Avifaunal Diversity from Various Green Spaces of Indore City, Madhya Pradesh. International Journal of Current Research and Reviews, 11(14):06-15.

Issa, A.A.I. (2019). Diversity and abundance of wild bird species in two different habitats at Sharkia Governorate, Egypt. The Journal of Applied Zoology, 80(34):1-7.

James, A.O.; Emmanuel, D. and Bright, A.Y. (2017). Diversity and Abundance of Bird species in Mole National Park, Damongo, Ghana. Journal of natural science research, 7(12):20-33.

Kumar, P. and Gupta, S.K. (2009). Diversity and Abundance of Wetland Birds around Kurukshetra, India. Our Nature,7: 212-217.

Kushwaha, S.; Kanaujia, A.; Kumar, A.; Kumar, A. and Maheshwari, S.K. (2015). Avifauna diversity of Tikamgarh District, Madhya Pradesh, India. Discovery Nature, 9(20):20-32.

Lodhi, R.K.;Dandotiya, B.;Gurjar, R.K.; Rawat, S.N.; Rambaboo and Rao, R.J. (2018). Study of Ramada Dam with Special reference to bird diversity and their conservation, Gwalior, Madhya Pradesh, India. International Journal of Creative Research Thoughts (IJCRT), 6(1):981-993.

Magurran, A.E.(2004). Measuring Biological Diversity. Blackwell Science Ltd. Oxford.

Pasha, M.K.S.;Jaypal, R.; Areendran, G.; Qureshi, Q. and Sanskar, K. (2004). Birds of Pench Tiger Reserve, Madhya Pradesh, Central India. Newsletter for Ornithologist,1:1-2.

Raju, D. and Ramachandran, S. (2016). Photographic field guide wildlife of Central India. Notion Press, Chennai,1-30.

Sahni, K.C. (2000). The Book of Indian Trees. Bombay Natural History Society, Oxford University Press, Mumbai.

Shekhawat, D.S. and Bhatnagar, C. (2014). Guild, status and Diversity of Avian Fauna in the Jhunjhunu district, Rajasthan, India. Journal of Asia-Pacific Biodiversity, XXX: 1-6.

Vallejo, B.M.; Aloy, A.B. and Ong, P.S. (2009). The distribution, abundance and diversity of birds in Manila's last greenspaces. Landscape and Urban Planning, 89 (3-4): 75-85.

IMPACT OF COVID-19 ON FISHERIES IN INDIA: PAST, PRESENT AND FUTURE

Sachin K. Shelake* and Vishwas Y. Deshpande

Department of Zoology and Fisheries,

Yashvantrao Chavan Institute of Science, Satara 415 001 M. S., India

Corresponding author E-mail: *sachinshelake1993@gmail.com, vydzoo@gmail.com

The World Health Organization declared COVID-19 as a pandemic on March 11, 2020. The virus spread over the globe in the first half of 2020. This disease created substantial direct and indirect problems to the fisheries sector (FAO.2021). The pandemic still in its active phase is affecting different parts of the world. With no respite in view the population has adapted and through various means attempts and efforts are being made to live with the virus.

The novel coronavirus SARS-CoV-2, also naming as COVID-19, has largely halted human activity in numerous parts of the world, resulting in multiple lockdowns. The worldwide GDP loss owing to the pandemic in 2020–2021 is expected to be over $9 trillion (Gopinath *et al.,* 2020). India, which is the size of a continent, imposed the first lockdown on its 1.3 billion people on March 24, 2020. The micro, minor, and medium-sized firms (MSMEs), which employ 110 million people and are the second-largest employer after agriculture, are having to cope with the economic downturn (Tripathi *et al.,* 2020). The Indian economy has already declined by 8.9 percent of GDP, with enterprises losing $8–16 billion every day (The Hindu, 2020; Sharma *et al.,* 2020). The epidemic has also had an impact on the fisheries sector, which is economically significant to India's coastal states (UNCTAD 2020).

India has a long coastline, and its coastal states/Union Territories (UT) contribute significantly to the nation's blue economy (CBD, 2020). The blue economy is described as the actual uses of ocean resources for economic growth, improved livelihoods and job creation while ensuring the health of the ocean ecosystem (The Blue Economy, 2020). The fisheries sector accounts for around 1.03 percent of India's GDP (2017–2018), with exports totaling $7.1 billion (Sathiadhas *et al.*, 2000).

Every year, the country generates more than 12 million tons of inland and marine fishery products, with the marine route accounting for a third of the total. According to India's National Fisheries Development Board (NFDB), the marine fisheries sector employs over 16 million fishing workers and their families (directly and indirectly) in 3477 marine fishing communities spread over the country's seventy coastal districts (Ghoshal *et al.*, 2020). This emphasizes the value of the Indian fishing sector and coastal regions, both in terms of livelihood and nutrition (Ram Avtar *et al.*, 2020)

According to the International Labor Organization (ILO), nearly 2.7 billion people, or 81 percent of the worldwide workforce, have been affected (ILO, 2020), with the informal sector suffering the most. On March 25, 2020 (Government of India, 2020), India imposed a countrywide lockdown, despite the fact that several states had previously implemented precautions. The first lockdown, which lasted 21 days, was eventually extended to May 3rd and then to May 31st. (Gopal *et al.*, 2019).

Fisheries activities before the pandemic:

India produced 13.34 million metric tons of fish in 2018-19, an increase of roughly 6% over the preceding year (Seafood Source, 2020). India exported 13, 77,244tons of fish worth $ 7.08 billion in 2018 (The Economic Times, 2018). In terms of inland fish production, Indian major carps have been the most cultivated species (Purkait *et al.,* 2020) led by exotic carps, catfishes, minor carps, and murrels (GoI, 2019). The fisheries activities were in full force in the Marine and estuarine areas. They were in some places resulting in over exploitation leading to depleting in number (Rav Avtar *et al.,* 2020). In the inland sector there was a boost in culture practices by utilizing the available water bodies. In the recent years there was a manifold increase in cage culture practices as the Governments at state level were nurturing such projects with financial assistance. In states like Maharashtra with farm ponds being provided with substantial subsidies the farmers latched on to the idea of culture of fishes. Thus there was a boost in the integrated fish farming practices where the farm ponds were used for fisheries along with horticulture, livestock, poultry or orchard development.

The present: COVID-19 and Fisheries:

The COVID-19 shock is constricting demand and supply in virtually identical ways all around the world, resulting in a global economic downturn. The situation in India may be long-term, as the Indian economy had deteriorated severely following years of poor performance prior to the COVID-19 period (Dev and Sengupta, 2020). Millions of people in India's fish sector have lost their jobs due to the worldwide pandemic, which has resulted in the loss of 10,000 metric tons of newly caught seafood and the stranding of over 15,000 migrant fish workers. The Ministry of Home Affairs (MHA) ultimately freed fisheries and aquaculture from lockdown restrictions on April 10th, 2020, two-thirds of the way into the first shutdown. However, it was too late; severe harm had already occurred. When the fisheries reopened, they were greeted with disrupted supply systems, a severe lack of customer demand, and an increasing concern of COVID-19 infection. Migrant fishermen, who make up a sizable chunk of India's mechanized, fishing sector, were unable to fish. They'd been stuck in shitty conditions for weeks, either aboard boats or in congested fishing ports, and all they wanted to do was return home (www.ipsnews.net).

Despite the fact that this addition to the yearly fishing restriction is only in effect until 2020, it makes no attempt to address contemporary challenges. The relaxation of restrictions on large scale andmotorized fishing has intensified the difficulties faced by small-scale fishermen and migrant labors in India, who are among the most exposed members of the country's diverse fishing community. This has not only increased competition and put fishermen's lives in danger in dangerous waters to provide services to nonexistent markets, but it has also raised the probability of poor fisher migrants being compelled to work as bonded laborers.These bad incidents have compromised the ban, as well as the decades of talks that have resulted in its amazing accomplishments and the protection it offers for India's dwindling marine resources.

The Future: COVID-19 and Fisheries:

Business as typical is no longer an option, according to COVID-19. It's a call to action to priorities people and the environment. Fisheries are the sole commercially viable supply of wild-caught protein, and they need to be treated with care. The present focus in India should be on the well-being and security of fishermen, the return of fisher refugees to their home positions, and the provision of commercial and food help to fishing communities.

This delay is also an excellent opportunity to consider and revise the National Fisheries Policy Draft 2020, as well as the planned investments of Rs 20,500 crore in marine, inland, and aquaculture. The new program does not provide direct aid to fishermen, instead favoring the industry's wealthier and more powerful members, and it lacks provisions to help India's fishing villages build social capital through education, medical, and environmental protection (Jaini, 2020).

Negative Impact:

The most selling food commodity on the planet is sea food, which includes fish and fish products. International commerce accounted for almost 38% of all seafood. Meanwhile, fishing and fish farming are key economic activities on a local level. Many low-income nations and populations that rely on fish for their livelihoods and island developing governments, rely on aquaculture to supplement their revenue. COVID-19 prevention efforts have created supply chain disruptions in both domestic and foreign markets (Love *et al.,* 2020).

Furthermore, extensive containment efforts have the potential to have a significant influence on nations. To avoid a worldwide food crisis, keeping the supply system open is critical.However, there are certain challenges with sea food production. Demand, labor, and production of sea food items are all disrupted as a result of the disturbance in the sea food system. Fish and seafood intake accounts for 20% of global animal protein intake (UNCTAD, 2019).

India is the second-largest shrimp exporter after China. Their economy relied heavily on the shrimp trade. The shrimp business was severely harmed by the COVID-19 outbreak. The majority of shrimp were sent to foreign nations.All commercial operations were halted under the social distancing and lockdown scenario, affecting shrimp output in India (Minahal *et al.*, 2020).

Effects were also felt by fish food producers who had to shut down their units due to lock downs and absence of manpower. The transport was also shut down and this resulted in heavy losses as the investments were high and returns almost nil.

The most affected were the fishing tribes and communities who rely on daily capture and selling of fishes from local water bodies. Due to stringent action and lock downs they suffered most as their income was halted and they had to face difficulties which are beyond imagination.

Positive Impact:

Most of the news is bad in this pandemic, but there are some positive signs, such as the efforts of the small scale fishery sector and partners to respond. As small scale fishery focuses their resources and expertise on making food security achievements within their communities, there are countless examples of food sharing (Ramirez, 2020).

NFDB (National Fisheries Development Board, India) taking some excellent initiatives in this pandemic situationfor both large scale fish farmers as well as small scale fishery sector by availing funds to farmers project in pre harvesting, post harvesting and food processing of fish products in the year 2020 (NFDB Annual report 2019-20).

In India the positive was in the replenishment of stock of fishes as their movements increased. Due to no fishing activities the fishes and other aquatic produce were surviving with no capture. There is a surge in demand for the fishes post Covid 19 and the local activities are on the rise.

Conclusion:

According to our findings, the COVID-19 epidemic poses significant problems to the worldwide fishing industry. While there are some excellent initiatives and accomplishments, the negative implications are likely to exceed them, particularly for those who are most affected by these developments are the most vulnerable. Moreover, the crisis is not yet ended. Long-term problems connected to commercial troubles and global food crises are expected to follow the short-term repercussions we've outlined here.Fisheries play crucial role for food and livelihood security all around the world. As a result, we underline the importance of all parties quickly mobilizing in support of the Fisheries industry. Rapid, targeted actions to the most vulnerable are required in the short term. Longer term, a concerted reaction and support network is needed to restructure current institutes, resource networks, and dietmanagement in ways that improve the Fisheries sector's circumstances and flexibility.

References:

Avtar, R.; Kumar, P.; Supe, H.; Jie, D.; Sahu, N.; Mishra, B.; Yunus, A. Did the COVID-19 Lockdown-Induced Hydrological Residence Time Intensify the Primary Productivity in Lakes? Observational Results Based on Satellite Remote Sensing. *Water*2020, *12*, 2573, doi:10.3390/w12092573.

Avtar, R.; Singh, D.; Umarhadi, D.A.; Yunus, A.P.; Misra, P.; Desai, P.N.; Kouser, A.; Kurniawan, T.A.; Phanindra, K. Impact of COVID-19 Lockdown on the Fisheries Sector: A Case Study from Three Harbors in Western India. Remote Sens. 2021, 13, 183. https://doi.org/10.3390/rs13020183.

Avtar, R.; Singh, D.; Umarhadi, D.A.; Yunus, A.P.;Misra, P.; Desai, P.N.; Kouser, A.; Kurniawan, T.A.; Phanindra, K. Impact of COVID-19 Lockdown on the Fisheries Sector: A Case Study from Three Harbors in Western India.Remote Sens. 2021, 13, 183.

CBD. The "Blue Economy" Is Critical to Food Security and the Fight Against Poverty. Available online: https://www.cbd.int/ article/waterforbiodiversity-2 (accessed on 11 May 2020).

Dev, S. M., &Sengupta, R. (2020). COVID- 19*: Impact on the Indian economy* (No. 2020-013). Indira Gandhi Institute of Development Research, Mumbai, India.

FAO.2021.The impact of COVID-19 on fisheries and aquaculture food systems, possible responses: Information paper, November 2020. Rome. https://doi.org/10.4060/cb2537en.

Ghoshal, S. Fisheries Sector Expected to Touch Rs 1.5 lakh Crore by 2020: Assocham.https://economictimes.indiatimes.com/news/economy/agriculture/fisheries-sector-expected-to-touch-rs-1-5-lakh-crore-by-2020-assocham/articleshow/58804708.cms?from=mdr (accessed on 20 May 2020).

GoI.(2019).Handbook of Fisheries Statistics 2018. Fisheries Statistics Division, Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. [online] Available at: <http://dof.gov.in/sites/default/filess/Handbook%20on%20FS%202018.pdf> [Accessed 2 May 2020].

Gopal, B. N., Edwin, L., & Ravishankar, C. N. (2019). COVID-19 THROWS THE INDIAN FISHERIES SECTOR OUT OF GEAR, 21–28.

Gopinath, G. The Great Lockdown: Worst Economic Downturn since the Great Depression. Available online:https://blogs.imf.org/2020/04/14/the-great-lockdown-worst-economic-downturn-since-the-great-depression/ (accessed on 31 May 2020).

https://www.worldbank.org/en/news/infographic/2017/06/06/blueeconomy (accessed on 20 May 2020).

India's fisheries: Past, present, and future: MahimaJaini, July 2, 2020

Love D, Allison EH, Asche F, Belton B, Cottrell RS, Froehlich HE, *et al*. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system 2020.

Miles, A., and K. Merrigan. 2020. If we get food right, we get everything right. Honolulu Civil Beat (blog).April 11, 2020.https://www.civilbeat.org/2020/04/if-we-get-food-right-we-get-everything-right/

Minahal, Q., Munir, S., Komal, W., Fatima, S., Liaqat, R., & Shehzadi, I. (2020). International Journal of Fisheries and Aquatic Studies 2020; 8(6): 42-48 Global impact of COVID-19 on aquaculture and fisheries: A review. *Fisheriesjournal.Com*, *8*(6), 42–48. Retrieved from http://www.fisheriesjournal.com

NFDB Annual report 2019-20.

Purkait, S., Karmakar, S., Chowdhury, S., Mali, P., &Sau, S.K. (2020). Impacts of Novel Coronavirus (COVID-19) Pandemic on Fisheries Sector in India: A Minireview, *Ind. J. Pure App. Biosci. 8*(3), 487-492. doi: http://dx.doi.org/10.18782/2582-2845.8179

Ramirez, E. 2020. Generosity in time of COVID-19: Fishermen in MX donate tons of fresh fish to the community.Remezcla (blog). April 23, 2020. https://remezcla.com/culture/giving-during-coronavirus-oaxacafisherman/

Sathiadhas, R.; Biradar, R.S. Fisheries in the Development of Indian Economy. In Proceedings of the National Conference on Fisheries Economics, Extension and Management, Mumbai, India, 5–6 January 2000; Central Marine Fisheries Research Institute (CMFRI): Mumbai, India, 2000; pp. 1–20.

Seafood Source:(2020). India strives to become top global seafood exporter. [online] Available at:<https://www.seafoodsource.com/news/supply-trade/india-strives-tobecometop-global-seafood-exporter> [Accessed 2 May 2020].

Sharma, Y.S. 27 Million Youth in Age Group of 20–30 Years Lost Jobs in April: CMIE.https://economictimes.indiatimes.com/news/economy/indicators/unemployment-rate-dips-to-23-97-data-from-cmie shows/articleshow/ 75689370.cms?from=mdr (accessed on 31 May 2020).

The Economic Times. (2018). Indian seafood export touches new high at $7.08 billion. [online] Available at: <https://economictimes.indiatimes.co m/news/economy/foreign-trade/indian -seafood-export-touches-new-high-at- 7-08 billion/articleshow/ 64825570. cms?from=mdr> [Accessed 2 May 2020].

The Hindu. Moody's Revises India's 2020 GDP Contraction Estimate to 8.9% from 9.6%. Available online: https://www.thehindu. com/business/Economy/moodys-revises-indias-2020-gdp-forecast-to-89-from-96/article33082321.ece# (accessed on 1 December 2020).

The World Bank: The Blue Economy

Tripathi, A. Covid-19 Effect on Micro, Small and Medium Enterprises (MSMEs). Available online: https://timesofindia.indiatimes. com/blogs/agyeya/covid-19-affect-on-micro-small-and-medium-enterprises-msmes/ (accessed on 31 May 2020).

UNCTAD.UNCTAD-World Oceans Day 2020 Report. In Proceedings of the The Blue Economy and COVID-19 Pandemic: New Challenges, Recovery Measures and Resilience, 4 June 2020; UNCTAD: Geneva, Switzerland, 2020.

GENETIC ENGINEERING APPLICATION IN ANIMAL BREEDING

Khan Rumana Amanullah
J. A. T. Arts, Science and Commerce College,
(For Women) Malegaon, M. S.
Corresponding author E-mail: khan.rumana1967@gmail.com

Abstract:

Genetic engineering refers to a set of techniques that employ recombination of DNA to make direct genetic changes to organisms or populations of organisms. The genetic material of cells, organs, or whole organisms may be identified, replicated, modified, and transferred using these processes. The creation of novel diagnostic procedures, medications for human and animal illnesses, foods for human health, and tissues and cells for xenotransplantation all need genetic engineering. Animals that have been genetically modified also improve human health and the environment because they are more effective at converting grain to animal protein and produce less waste. Finally, genetic engineering will increase animal welfare by conferring disease resistance and improving general health and well-being. In vitro techniques for studying genes and their control, numerous approaches for gene therapy, and the production of novel strains of existing microbes for medicinal or industrial application are all included in genetic engineering. It also encompasses a set of approaches for genetically altering organisms. These methods entail being able to extract, cut, and transfer particular DNA fragments that correspond to certain genes.

Keywords: Genetic engineering, techniques, livestock, gene therapy

Introduction:

Genetic engineering, often known as genetic alteration, is the use of biotechnology to directly manipulate an organism's DNA. Genetic engineering involves removing heritable material from an organism's genetic composition or introducing DNA generated outside the organism straight into the host or into a cell that is subsequently fused or hybridised with the host. This entails creating novel combinations of heritable genetic material using recombinant nucleic acid (DNA or RNA) procedures, then incorporating that material either indirectly through a vector system or directly by micro-injection, macro-injection, and micro-encapsulation techniques. Cattle, sheep, pigs, and poultry have all benefited from genetic advancements that have improved the effectiveness of desired characteristics. Among its advanced applications in

livestock breeding are increased animal output and productivity (meat, milk, wool), better disease resistance, and biomedical purposes (vaccine production).

Transgenic techniques:

Microinjection of DNA and, more recently, nuclear transfer are two approaches for effectively producing transgenic animals. The steps involved in creating transgenic models are rather simple. Once a specific fusion gene including a promoter and the gene to be expressed has been cloned and described, adequate amounts are extracted, purified, and tested in cell culture if possible before being used in early mammalian gene transfer experiments. Unlike nuclear transfer research, DNA microinjection procedures were carried out first in mice (Izquierdo, 2001). While the transgenic mouse model does not always predict expected phenotypic expression patterns in domestic animals, no construct has ever worked in a pig when there was no indication of transgene expression in mice. Preliminary testing in mice has always been an important part of every gene transfer work in domestic animals. While nuclear transfer in its current form may be deemed inefficient, considerable breakthroughs in experimental techniques are expected. The addition of gene targeting by nuclear transplantation brings up a whole slew of new possibilities, particularly in terms of using transgenic animals to make human drugs. The development of technologies for in vitro maturation of oocytes (IVM), in vitro fertilisation (IVF), and subsequent culture of implanted embryos before to transfer to recipient females has been the sole major technological progress since the original generation of transgenic farm animals. Another extremely effective transgenesis method that is based on the use of lentiviral vectors to modify cow and pig oocytes was recently developed. In terms of transformation and expression rates, these vectors tend to outperform microinjection. One restriction is that the transgene and internal promoter must both be under 8.5 kb in size.

Transgenesis in the improvement of production traits:

Transgenesis technology has the ability to quickly and precisely change economically important traits. In contrast to 'traditional' selection processes, knowledge of the genes that govern these traits and their regulation is required. Here's a quick rundown of how transgenesis has been used to change economically relevant features in animals. Growth hormone was increased by the metallotionein promoter to regulate its expression in most of the previous research in domestic species (pig, sheep, rabbit). Production of transgenic swine and cattle with a foreign c-ski oncogene that targets skeletal muscle, as well as investigations of growth in mouse and sheep lines that express transgenes independently encoding growth hormone-releasing factor (GRF) or insulin-like growth factor I were among the subsequent efforts to genetically alter growth rates and patterns (IGF-I) Although transgenic pigs and lambs with high amounts of

serum growth hormone were produced, no improvement in their rate of growth was seen, and only in select lines did average daily gain rise with the addition of high-protein diets.

The best results were shown in the area of body fat reduction. These animals were found to have a variety of significant diseases as well as a dramatic loss in reproductive potential (Murray *et al.* 1999). There is evidence for the use of transgenesis in two experiments with pigs (Neimann, 1998), with enhanced IGF-I levels and growth hormone allowing for significant reductions in body fat and increased diameter of muscle fibre without major pathological side effects. The commercial release of these creatures was prohibited under Australian legislation. Frequently, the promoters chosen did not allow for effective transgenic expression control. It was determined that more complicated constructs are required to more accurately activate or suppress transgenic expression. According to Adams *et al.* (2002), the influence of a growth hormone construct in sheep on growth and meat quality yielded mixed findings. The injection of a plant gene into pigs has produced a stunning metamorphosis. Saeki *et al.* (2004) created transgenic pigs with the fatty acid desaturation 2 gene, which encodes a 12-fatty acid desaturase found in spinach. Linoleic acid (18:2n-6) levels were 10 times higher in adipocytes generated in vitro from transgenic pig cells than in wildtype pig cells. Furthermore, transgenic pigs' white adipose tissue contained 20% more linoleic acid (18:2n-6) than wild-type pigs' white adipose tissue. These results indicate that a plant gene for a fatty acid desaturase may be expressed in mammals, indicating that transgenic technology could be used to alter the fatty acid composition of domestic animal products. Production of wool The goals are to increase sheep wool output while also altering the fiber's characteristics. Because cystein appears to be the limiting amino acid for wool production, the initial strategy was to transfer cystein manufacturing from bacterial genes to the sheep genome (Murray *et al.* 1999).

The effective expression of these enzymes in the rumen of transgenic sheep was not achieved using this method. Composition of milk Unique copy genes code for milk proteins, which may be changed to change the content and qualities of milk. The following are some of the many uses of milk modification in transgenic animals (Maga and Murray, 1995; Murray et al., 1999): 1. Bovine milk will be modified to make it more suitable for newborn ingestion. When compared to bovine milk, human milk lacks -lactoglobulin, has a stronger connection of serum proteins to caseins, and has a larger amount of lactoferrin and lysozyme. Lactoferrin is a protein that transports iron and suppresses bacterial growth. Transgenic cows have been created to incorporate human lactoferrin into bovine milk (Van Berkel *et al.* 2002). Another intriguing

goal would be to eliminate -lactoglobulin from cow milk, as it is one of the most common allergies in cow's milk.

Conclusion:

Agricultural animals' health and welfare might be dramatically improved via genetic engineering. Disease resistance, parasite resistance, and stress tolerance may all be traits of GE animals. Because they will be more productive, the favorable characteristic will most likely boost their well-being.

Many theoretical and practical aspects of gene function and organization have been improved because to genetic engineering. Bacteria capable of manufacturing human insulin, human growth hormone, alpha interferon, a hepatitis B vaccine, and other therapeutically important compounds have been developed using recombinant DNA technology. Plants may be genetically modified to fix nitrogen, and genetic illnesses can be treated by replacing faulty genes with ones that work correctly. Toxin-producing genes have been inserted into various plant species, including corn and cotton. Crop plants have also been inoculated with bacterial genes that give herbicide resistance. Other attempts at plant genetic engineering have tried to improve the plant's nutritional value.

Insulin, human growth hormones, follistim (an infertility therapy), human albumin, monoclonal antibodies, antihemophilic factors, vaccines, and a range of other pharmaceuticals have all been mass-produced through genetic engineering. Organisms are genetically modified in study to learn more about the roles of certain genes. Agricultural animals' health and welfare might be dramatically improved thanks to genetic engineering. Disease resistance, parasite resistance, and stress tolerance may all be traits of GE animals. Because they will be more productive, the favourable characteristic will most likely boost their well-being.

References:

Animal Procedures Committee. Report of the Animal Procedures Committee for (1999). London

Dekkers, J.C.M. 2004. Business use of marker-and quality helped choice in animals: Strategies and examples. Diary of Animal Science 82(E. Suppl.):E313–E328.

Deng, G. and Wu, R. (1981). A further developed technique for using terminal transferase to add homopolymers to the 3′ ends of DNA. Nucleic Acids Research, 9, 4173–4188

Evans, G.J., Giuffra, E., Sanchez, A., Kerje, S., Davalos, G., Vidal, O., Illa'n, S., Noguera, J.L.,Varona, L., Velander, I., Southwood, O.I., de Koning, D.- J., Haley, C.S., Plastow,

G.S. furthermore Andersson, L. (2003). Recognizable proof of quantitative quality loci for creation attributes in business pig populaces. Hereditary qualities 164:621–627.

Frisch, J.E. 1984. Hereditary credits needed for effective dairy cattle creation in the jungles. In: Baker, F.H. nd Miller, M.E. (eds), Beef dairy cattle science handbook. Volume 20. Winrock International Project, Westview Press, Boulder, Colorado, USA.

Hanotte, O., Ronin, Y., Agaba, M., Nilsson, P., Gelhous, A., Horstmann, R., Sgimoto, Y., Kemp, S., Gibson, J., Korol, A., Soller, M and Teale A. (2003). planning of quantitative attribute loci controlling trypanotolerance in a cross of open minded West African N'Dama and defenseless East African Boran dairy cattle. Procedures of the National Academy of Sciences 100 (13): 7443-7448.

Karp, Gerald (2008). Cell and Molecular Biology: ideas and Experiments. third New York, Willey, 785 p. ISBN04-714-6580.

Kosgey, I.S., Baker, R.L., Udo, H.M.J., van Arendonk, J.A.M. (2006). Triumphs and disappointments of little ruminant reproducing programs in the jungles: an audit. Little Ruminant Research 61:13–28.

Kosgey, I.S., Okeyo A. M. (2006). Hereditary improvement of little ruminants in low-input smallholder creation frameworks: Technical and infrastructural issues. Little Ruminant Research (Submitted) Interbull Bulletin 33. 2005. SLU, Uppsala, Sweden.

Silva J, Kidwell M. Level exchange and choice in the development of P components.

MOTHS (LEPIDOPTERA) OF SHRI SHIVAJI ART, COMMERCE AND SCIENCE COLLEGE AND ADJOINING AREAS, AKOLA: AN INITIAL CHECKLIST

Priyanka M. Ramteke

Department of Zoology,

Shri Shivaji Art, Commerce and Science College,

Akola, Maharashtra, India

Corresponding author E-mail: priyanka.ramteke753@gmail.com

Abstract:

Moths are diverse group of insects belonging to the order Lepidoptera and regarded as one of the indicators of a healthy environment. This study deals with the first documentation on the moth species of Shivaji Art, commerce and Science College campus and its adjoining areas of Akola, M.S. The study was and Adjoining Areas, Akola carried out from September 2019 to March 2020, surveying areas mostly in the college campus, human settlements and agricultural lands. The survey examined the light illuminated walls of the College campus where moths accumulated during the evening hours. Light trapping equipped with 18w UV-Actinic tube was also used to record moths from nearby agricultural lands. In total, 24 moth individuals were recorded belonging to 24 species Within 24 genera falling under 10 families.. The family Noctuidae -7 represented the highest number of species, followed by Crambidae -4 , Sphingidae -3, and Lymantriidae -3 . the less commonly observed species belonging to families are Geometridae-1, Arctiidae-2, Saturniidae-1, Thyrididae -1 and nolidae-1 individuals respectively.

Keywords: Shivaji Art, commerce and Science College campus, Moths, Lepidoptera, Inventory.

Introduction:

Shri Shivaji Art, commerce and Science College Campus and its adjoining areas of Panjabrao Deshmukh Krushi Vidyapeeth, of Akola town of the Vidharbha State of Maharashtra. Situated at latitude 20.7^0 North and longitudinal 77.07 ^{0}East.It is an altitude of 925ft(287m) to 1036.745ft (316m) above sea level. Akola has tropical savanna climate Annual temperature range from a high of 47.6^0c to a low 2.2^0c. Annual rain fall averages 800mm.

Among the winged insects, the moths belong to the scientific order Lepidoptera including the butterflies. They can be distinguished from all other insects by the two pair of wings and the body that is scale covered. Regarded as indicators of healthy environment, inventory of

Lepidoptera specially the overlooked group is the first step to know what are the species present in an area and it is essential to ensure future taxonomical and ecological studies of these taxa and implement conservation perspectives for moth individuals as well as their associated habitats.

Global estimates show that there are 1, 27,000 species of moths distributed over the world and of which, 12,000 species are reported from India. Moths are in general are least studied taxa across the globe and in India. Despite a large number of studies been taken up on the

Documentation of various wildlife taxa found in and around Shri Shivaji Art, commerce and Science College Campus by the biologists, information on Moths of this region remains unknown. The present study is the first documentation on the moth species of Shri Shivaji Art, commerce and Science College Campus and its adjoining areas.

Materials and Methods:

The study was carried out from September 2019 to March 2020 surveying areas mostly in the college campus, human settlements and agricultural lands. Light trapping equipped with a 18w UV-Actinic tube attached to a white sheet 6 x 4 feet joined to two poles and then the tube powered by 6v Battery, which was used to record moths from playgrounds of college, human settlements and agricultural lands.

In addition, the survey also examined the campuses of Shri Shivaji Art, commerce and Science College and Panjabrao Deshmukh Krushi Vidyapeeth in each campus the college building walls, which were with bright electrical lights during late evening hours followed by the next morning to observe the accumulation of moths resting over the light illuminated walls.

The moths were photographed and identified and those that were difficult to identify were kept for proper identification. Among the literatures, Fauna of British India: Moths Volume I-V by G.F Hampson was referred for identification along with other journals.

Results and Discussion:

A total of 24 moth individuals were recorded belonging to 24 species Within 24 genera falling under 10 families. A checklist of the moth Species is tabulated in Table 1.

The accumulation of moths in a light source depends on the type of light source, plant communities occurring around the study site, temperature, weather conditions, altitudinal gradient, and the type of methods implemented. The moths recorded by visiting the mentioned Localities and sheet light trap method were a valuable source for developing a preliminary data record for moths occurring in this region. The notable species accumulated in the Agro-based

habitats were *Asota caricae* (Fabricius, 1775), *Remigia undata* (Fabricius, 1775), *Ophideres maternal* (Linnaeus, 1762) ,*Spirama retorta* (Clerk, 1764), *Aedia sp.*, *Ophiusa tirrhaca* (Cramer, 1777) and *Grammodes geometrica* (Fabricius, 1775) belongs to Noctuidae family on their host plants namely *Mangifera indica* (Mango) , *Musa paradisiaca* (Banana), *Citrus*, *Solanum lycopersicum* (Tomatoes).

The moths recorded belonged to 10 families, among them *Caprinia conchylasis*, *Diaphania indica* (Saunder, 1851), *Pygospila tyres* (Cramer, 1780) and *spoladea recurvalis* (Fabricius, 1775) Moths (Family: Crambidae) observed as a minor pest of potato and cucumber in Panjabrao Deshmukh Krushi Vidyapeeth The family Sphingidae (Hawkmoths) was represented by *Macroglossum* (Scopoli, 1777) species (humming bird hawkmoth) which was found number of times hovering near hibiscus flowers during the dusk hours. *Acherontia styx* (Death's Head Hawk moth) known as bee robber and *Agrius convolvuli* (Linnaeus, 1758) was sighted two times in Shri Shivaji Art, commerce and Science College Campus.

Euproctis lunata (Walker, 1855), *Euproctis sp*. (Walker, 1855) *and Lymantria* sp.(Hubner, 1819) belong to family Lymantiidae species of moths recorded near the agrobased campus.

The Geometridae (Geometer/looper moths) represented a few species of moth which include *Macaria fasciata* (Fabricius, 1775) observed as a pest on Acacia nilotica (babul) and Nerium indicum (kaner) plant in agrobased campus.

Arctiidae family represents two species of moth Pericallia *ricini* (Fabricius, 1775) and *Creatonotus gangis* (Linnaeus, 1763) on their host plants namely *Musa paradisiaca* (Banana).

The species *Actias selene* (Hubner, 1807), *Banisia myrtaea* (Drury, 1764), *Micronia aculeate* (Guenee, 1857) and *Acotia transversa* (Guenee, 1852) represented the family Saturniidae, Thyrididae, Uraniidae and nolidae respectively. These four families appeared to be scarce representing single species. Near the host plant namely hibiscus, lantanas, syzygium jambo, almond tree in agro based campus and adjoining area.

Table 1: List of moth species of Shri Shivaji Art, commerce and Science College and adjoining areas

Sr. No.	Name of the species	Family	Subfamily	Genus
1.	*Asota caricae* (Fabricius 1775)	Noctuidae	Aganainae	*Asota*
2.	*Aedia species (Hubner 1823)*	Noctuidae	-	*Aedia*
3.	*Grammodes geometrica* (Fabricius 1775)	Noctuidae	-	*Grammodes*
4.	*Ophiusa tirrhaca (Cramer 1777)*	Noctuidae	Catocalinae	*Ophiusa*
5.	*Ophideres materna* (Linnaeus 1762)	Noctuidae	Calpinae	*Ophideres*
6.	*Remigia undata* (Fabricius 1775)	Noctuidae	Catocalinae	*Remigia*
7.	*Spirama retorta* Clerck (1764)	Noctuidae	Catocalinae	*Spirama*
8.	*Caprinia conchylasis* Guenee	Crambidae	Spilomelinae	*Caprinia*
9.	*Diaphania indica* (Saunders 1851)	Crambidae	Spilomelinae	*Diaphania*
10.	*Pygospila tyres* (Cramer 1780)	Crambidae	Spilomelinae	*Pygospila*
11.	*spoladea recurvalis* (Fabricius 1775)	Crambidae	Spilomelinae	*spoladea*
12.	*Acherontia styx* (Linnaeus 1758)	Sphingidae	Sphinginae	*Acherontia*
13.	*Agrius convolvuli* (Linnaeus 1758)	Sphingidae	Sphinginae	*Agrius*
14.	*Macroglossum* sp. (Scopoli 1777)	Sphingidae	Macroglossinae	*Macroglossum*
15.	*Euproctis lunata* (Walker 1855)	Lymantriidae	-	*Euproctis*
16.	*Euproctis sp.(Walker 1855)*	Lymantriidae	-	*Euproctis*
17.	*Lymantria* sp.*(Hubner 1819)*	Lymantriidae	-	*Lymantria*
18.	*Macaria fasciata*(fabricus1775)	Geometridae	Ennominae	*Macaria*
19.	*Pericallia ricini* (Fabricius 1775)	Arctiidae	Arctiinae	*Pericallia*
20.	*Creatonotus gangis* (Linnaeus1763)	Arctiidae	Arctiinae	*Creatonotus*
21.	*Actias selene* (Hubner 1807)	Saturniidae	Saturniinae	*Actias*
22.	*Banisia myrtaea* (Drury 1773)	Thyrididae	Striglininae	*Banisia*
23.	*Micronia aculeata* (Guenee 1857)	Uraniidae	Uraniinae	*Micronia*
24.	*Acotia transversa* (Guenee 1852)	nolidae	Chloephorinae	*Acotia*)

Images of some moths of Shri Shivaji art, Commerce and Science College and adjoining area

Asota caricae

Aedia species.

Grammodes geometrica

Ophiusa tirrhaca

Ophideres materna

Remigia undata

Spirama retorta

Caprinia conchylasis

Diaphania indica

Pygospila tyres

spoladea recurvalis

Acherontia styx

Agrius convolvuli

***Macroglossum* sp**

Euproctis lunata

Euproctis sp

***Lymantria* sp.**

Macaria fasciata

Pericallia ricini

Creatonotus gangis

Actias selene

Banisia myrtaea

Micronia aculeata

Acotia transversa

Conclusion:

Some moths are farmed for their economic value. The most notable of this is the silk worms the larva of domesticated moth *Bombyx mori.* It is farmed for the silk with which it builds its cocoon. Not all silk is produced by *Bobyx mori*. There are several species of Saturniidae, that also are farmed for their silk, such as the Ailanthus moth (*Samia Cynthia* group of species), the Chinese oak silkmoth (*Antheraea pernyi*), the Assam silkmoth (*Antheraea assamesnsis*), and the Japanese silk moth (*Antheraea yamamai*).

The larvae of many species are used as food, particularly in Africa, where they are an important source of nutrition. The mopane worms, the caterpillar of Gonimbrasia belina,from the family Saturniidae, is a significant food resource in Southern Africa .Another Saturniidae used as food is the cavorting emperor (*Usta terpsichore*).

Moths also play a vital role in telling us about the health of our environment, like the canary in the coalmine .since they are so widespread and found in so many different habitats, and are so sensitive to changes; moths are particularly useful as indicator species. Monitoring their number and ranges can give us vital clues to changes in our own environment, such as the effect of new farming practices, pesticides, air pollution and climate change.

References:

Clerk 1764: *Spirama retorta Icon.Insect. rariorum2: pl. [54]*.

Cramer 1777: *Ophiusa tirrhaca* Lepidoptera and some other life forms retrieved December 2, 2019.

Cramer 1780: *Pygospila tyres* Cramer P. De uitlandsche Kapellen voorkomende in de drie waereld-deelen Asia, Africa en America, by een verzameld en beschreeven door den heer Pieter Cramer (etc.). — [1779]–[1780]

Drury1773: *Banisia myrtaea* Ilustration of exotic entomology. Retrieved august 23, 2016.

Fabricius 1775 : *Pericallia ricini* "Lepidoptera and some other life forms retrievedJanuary 21, 2019.

Fabricius1775: *Asota caricae* ICAR national bureau of agricultural insect resources. Retrieved 22 july, 2016.

Fabricius1775: *Grammodes geometrica* Australian caterpillars and their Butterflies and Moths. retrievedJanuary 15 ,2019.

Fabricius1775: *Macaria fasciata* Fabricius, 1775 in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-10-08.

Fabricius1775: *Remigia undata* Hampson,G.F.1895. The Fauna of British India including Ceylon and Burma, Moths-3. Taylor and Francis Ltd., London : 1-546.

Fabricius1775: *Spoladea recurvalis* Fabricius J. C. Systema Entomologiae sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus. — 1775

Guenee *in Boisduval and Guenee* 1852*; Acotia transversa* Histoire Naturelle des Insectes. Species General des Lepidopteres. 1-443.

Guenee *in Boisduval and Guenee* 1857; *Micronia aculeate* Histoire Naturelle des Insectes. Species General des Lepidopteres. Volume 10.

Hubner 1807:.*Actias Selene* Arora and Gupta. Mem. Zoo. Sur. India, 16 (1):12.

Hubner 1819: *Lymantria sp:* (Lepidoptera:Lymantriidae) from subtropical and temperate region of Asia, including the description of three new species,some potentially invasive to north America.

Linnaeus 1758: *Agricus convovuli* "Convovulus hawkmoth"Sphingidae of Eastern palaeartic retrieved December 13, 2018.

Linnaeus1762: *Ophideres maternal* Catalogue of lepidoptera of the French Antilles Retrieved september 12, 2019.

Linnaeus 1763: *Creatonotus gangis* Lepidoptera larva of Australia. Retrieved February 19, 2011.

Saunder 1851: *Diaphania indica* Peter,C and David, B; 'Insect –host plant interaction in relation to development of *Daphnia indica* .The journal of Bombay Natural History Society.,89, 1992.

Scopoli 1777: Lepidoptera: Sphingidae, *Macroglossinae* in Hong Kong Roger Kendrick C and R Wildlife, 129 San Tsuen Lam Tsuen, Tai Po , New Territories, Hong Kong.

Walker 1855: *Euproctis sp* "Lepidoptera and some other life forms retrieved April 8, 2019.

Walker1855: *Euproctis lunata "*Lepidoptera and some other life forms retrieved october 8, 2018.

A PRELIMINARY SURVEY ON THE POSSIBLE MOSQUITO OVIPOSITION SITES IN NAIHATI, NORTH 24 PARGANAS, WEST BENGAL DURING MONSOON AND POST MONSOON PERIOD

Jibandeep Ghosh and Jayati Ghosh*

Post Graduate Department of Zoology,

Barasat Govt. College; 10, K. N. C. Road, Barasat,

24 Pgs North, Kolkata – 700 124, West Bengal, India

*Corresponding author E-mail: jayatizoology@gmail.com

Abstract:

A survey was carried out in between August 2019 and December, 2019 in six selected sites of Naihati municipality in Barrackpore subdivision of North 24 Parganas district in the Indian state of West Bengal to investigate on the possible mosquito breeding sites during monsoon and post monsoon period and to study distribution of different genus in various larval habitat of the study area. Larvae of four mosquito genera namely *Aedes, Anopheles, Culex* and *Toxorhynchites* were obtained from the collection sites. The highest mosquitoe density was 40% in the month of November followed by 22.08% in October and 17.91% in September, 12.83% in December and lowest 7.16% in August. Among the collected mosquitoes 82.19% belong to genus *Aedes*, 15.02% are of genus *Culex*, 0.69% *Anopheles* and 2.08% belong to genus *Toxorhynchites* spp. The dominant habitat observed for *Aedes* and *Toxorhynchites* larvae were natural water source like tree holes but for *Culex* mosquito it was mostly artificial well water. *Aedes* and *Culex* larvae were dominant species but *Aedes* was most frequent whereas *Culex* occurred in moderate number. *Toxorhynchites* were found to be infrequent and sub-dominant species and *Anopheles* was sporadic and a satellite species.

Keywords: Mosquito larva, habitat, season, tree hole, oviposition

Introduction:

Larval habitats affect the breeding pattern and population growth of vector mosquito species. For developing an effective mosquito control program study of physicochemical characteristics of the breeding sites and larval breeding pattern are essential (Manguin and Boëte, 2011). Mosquito can breed in a variety of natural and artificial aquatic environment and ecological condition (Rueda, 2007; Becker *et al*., 2012). A female mosquito chooses their oviposition sites based on food availability in the waterbody utilising visual and chemical cues (Bentley and Day, 1989).

Immature stages of mosquito generally thrive in standing water bodies and utilises the resources present there for reproduction. The population structure and distribution of immature stages of mosquitoes depends mostly on food preference, competion and presence of predator species (Carlson *et al*., 2004). Moreover, the quality of aquatic habitat which is constantly changing due to accumulation of chemical and organic wastes also influences oviposition and progeny survival. In India *Anopheles stephensi*, *Culex vishnui* and *Aedes albopictus* are considered to be the primary vector for transmitting malaria, encephalitis and dengue respectively in urban areas (NVBDCP, Government of India, 2014–15).

As stated in the report of Directorate of Health Service (DHS), Govt. of West Bengal, 2016 North 24 Parganas reported 8250 dengue cases from the state (SBHI, DHS, Government of West Bengal, 2015–2016). Therefore, in our present study a preliminary survey was carried out in Naihati municipality in Barrackpore subdivision of North 24 Parganas district to get a primary idea on the possible mosquito oviposition sites during monsoon and post monsoon period and about the composition and distribution of different genus in various larval habitat of the locality.

Material and Methods:

Description of the study area

A survey was carried out between August, 2019 and December, 2019 in selected sites of Naihati municipality (22.9°N 88.42°E) in Barrackpore subdivision of North 24 Parganas district in the Indian state of West Bengal (Fig. 1). The area has an average elevation of 15 metres. It comprises of a total population of 217,900 people as per the 2011 Census of India. The climate is tropical and the summer season is hot and humid (March to May) and monsoon starts from June and lasts upto October. It is a highly urbanized area with large scale industries. The main water source for the town is the river Hugli.

Collection of larval stages of mosquito

The mosquito larvae were collected randomly from six types of habitat namely tree holes, earthen pot, tub, well water, tank and plastic packet (Fig. 2). Sampling was done using standard dipping method. In this technique a dipper was placed gently below the water surface at an angle of 45° to collect larval sample. In each habitat 2-10 dips were taken and collected larvae were preserved in eppendorf tube containing 70% alcohol. Tubes were properly labelled and taken to the laboratory of Department of Zoology, Barasat Government College for proper identification. The fourth instar larvae were used for identification of the mosquito genus following identification key (Rueda, 2004) under a dissecting microscope.

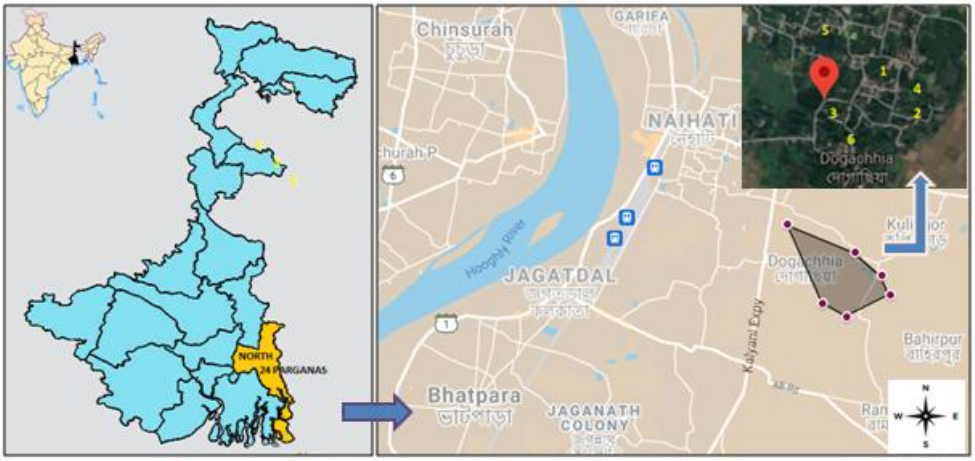


Figure 1: Map of the study sites. Sample collection sites are presented with numbers

Data Analysis

i) Seasonal variations of selected mosquito genera were analyzed by calculating relative abundance by using the given formula (Ali and Rasheed, 2009).

Relative abundance = n / L x100

Where *n* = number of each species specimens, *L* = total number of specimens. Different relative abundance classes of mosquito genus were made. When relative abundance is less than one, mosquito is classified as satellite species. In case of sub-dominant species relative abundance is less than five and more than five values are classified as dominant species.

ii) Identification of percent distribution of all mosquito genuses in various habitats (Ali N *et al.*, 2013).

Percent Distribution (C) = n / N x 100

Where *n* = number of those habitats where species was found, *N* = total number of habitats.

According to percent distribution differential distribution of mosquito's genus were also prepared in Table 1

Table 1: Classification of mosquito Genus based on their distribution

Distribution (%)	Classification
0-20%	Sporadic
20.1-40%	Infrequent
40.1-60%	Moderate
60.1-80%	Frequent
80.1-100%	Constant

iii) Average larvae of different mosquito genera per dip was determined by dividing total number of larvae of each genus collected in each habitat by number of dips performed to get the mean value.

Tree hole **Earthen pot** **Tub**

Well water **Tank** **Plastic container**

Figure 2: Different Mosquito larval habitats used for sampling

Results:

During this study period a total number of 1924 mosquito larvae were collected from six different study sites of Naihati, district North 24 Parganas. After taxonomic identification it was found that the larvae belong to four mosquito genera namely *Aedes*, *Anopheles*, *Culex* and *Toxorhynchites.* The collected mosquito genus belongs to six species namely *Aedes albopictus, Aedes aegypti, Culex pipiens, Culex vishnui, Anopheles stephensi* and *Toxorhynchites splendens.* The highest mosquitoe density was 346 (40%) in the month of November while it is lowest in August 62 (7.16%). From the Month of August the density of different mosquito species gradually increased in September (17.91%) and October (22.08%) and reached highest value during the month of November. Occurrence of the mosquito larvae gradually decreased in December again (12.83%) (Table 2).

Table 2: Monthly average larvae of different mosquito genera per dip in selected habitats in Naihati, North 24 pgs, West Bengal

Month	Mosquito species	Habitat Type						Total of each genus	Total of each month
		Tree hole	Earthen pot	Tub	Well water	Tank	Plastic packet		
August	***Aedes***	25	28	0	0	5	0	58	62 (7.16%)
	Culex	0	0	4	0	0	0	4	
September	***Aedes***	90	46	0	0	0	19	155	155 (17.91%)
October	***Aedes***	97	60	0	0	0	0	157	191 (22.08%)
	Culex	3	0	0	11	0	0	14	
	Anopheles	6	0	0	0	0	0	6	
	Toxorhynchites	12	0	0	0	2	0	14	
November	***Aedes***	197	60	0	2	0	0	259	346 (40%)
	Culex	0	0	0	83	0	0	83	
	Anopheles	0	0	0	0	0	0	0	
	Toxorhynchites	4	0	0	0	0	0	4	
December	***Aedes***	0	0	0	82	0	0	82	111 (12.83%)
	Culex	0	0	0	29	0	0	29	
	Anopheles	0	0	0	0	0	0	0	
	Toxorhynchites	0	0	0	0	0	0	0	
Total		434	194	4	207	7	19		865

Total volume of water 200ml in each dip

Out of average 865 larvae population, 711(82.19%) belong to genus *Aedes*, 130(15.02%) identified as genus *Culex*, 6 (0.69%) *Anopheles* and 18(2.08%) belong to genus *Toxorhynchites* spp. (Fig.3).

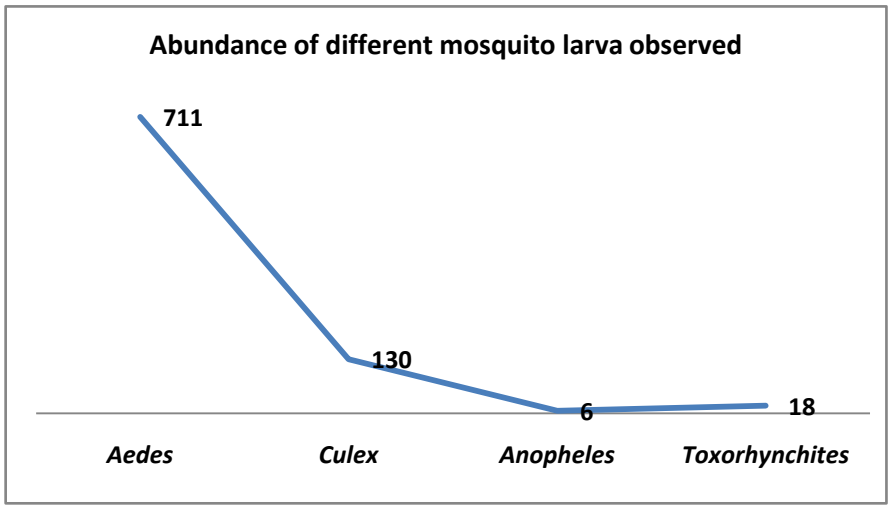


Figure 3: Abundance of different mosquito larva observed in the study area

The average larvae of *Aedes* species per dip in August were 58 which are lowest in number and 8.15% of the total average larvae of the genus collected in five months. It increased gradually in September to 155 (21.8%) and in October to 157 (22.08%) and became highest in November upto 259 (36.42%). In winter the activities of the genus were observed to be lower again to 82 (11.53%).

The average larvae of *Culex* species per dip in August were 4 which are low in number (3.07%) and no larvae obtained in September but gradually increased in October to 14 (10.76%) and reached highest number in November upto 83 (63.35%) and again decreased in December to 29 (22.30%). We obtained *Anopheles* in very low numbers in October only. *Toxorhynchites* spp., potentially ideal biological control agents of mosquito larva were 14 (77.77%) in the month of October and 4 (22.22%) only in November (Table 2) (Fig 4).

Habitat specificity of *Aedes* was highest in tree hole (57%) followed by earthen pot (27%), well water (12%), plastic container (3%) and tank (0.703%).The dominant habitat for *Culex* spp. was the well water (95%) followed by tub (3%) and tree hole (2%). Habitat specificity of *Toxorhynchites* was highest in tree hole (89%) and few larvae were found in tank (11%) (Fig. 5).

In terms of distribution genus *Aedes* was frequent, *Anopheles* was sporadic and genus *Culex* was moderate and *Toxorhynchites* sp. was infrequent (Table 3). On the basis of relative

abundance two genuses *Aedes* and *Culex* were dominant; *Toxorhynchites* was sub-dominant while *Anopheles* was identified as satellite specie (Table 4).

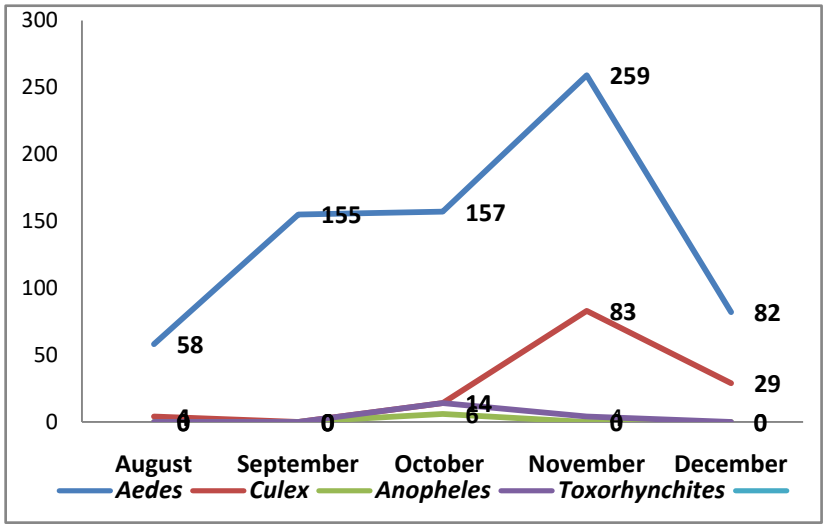


Figure 4: Seasonal distribution of different mosquito larva from Aug-Dec, 2019

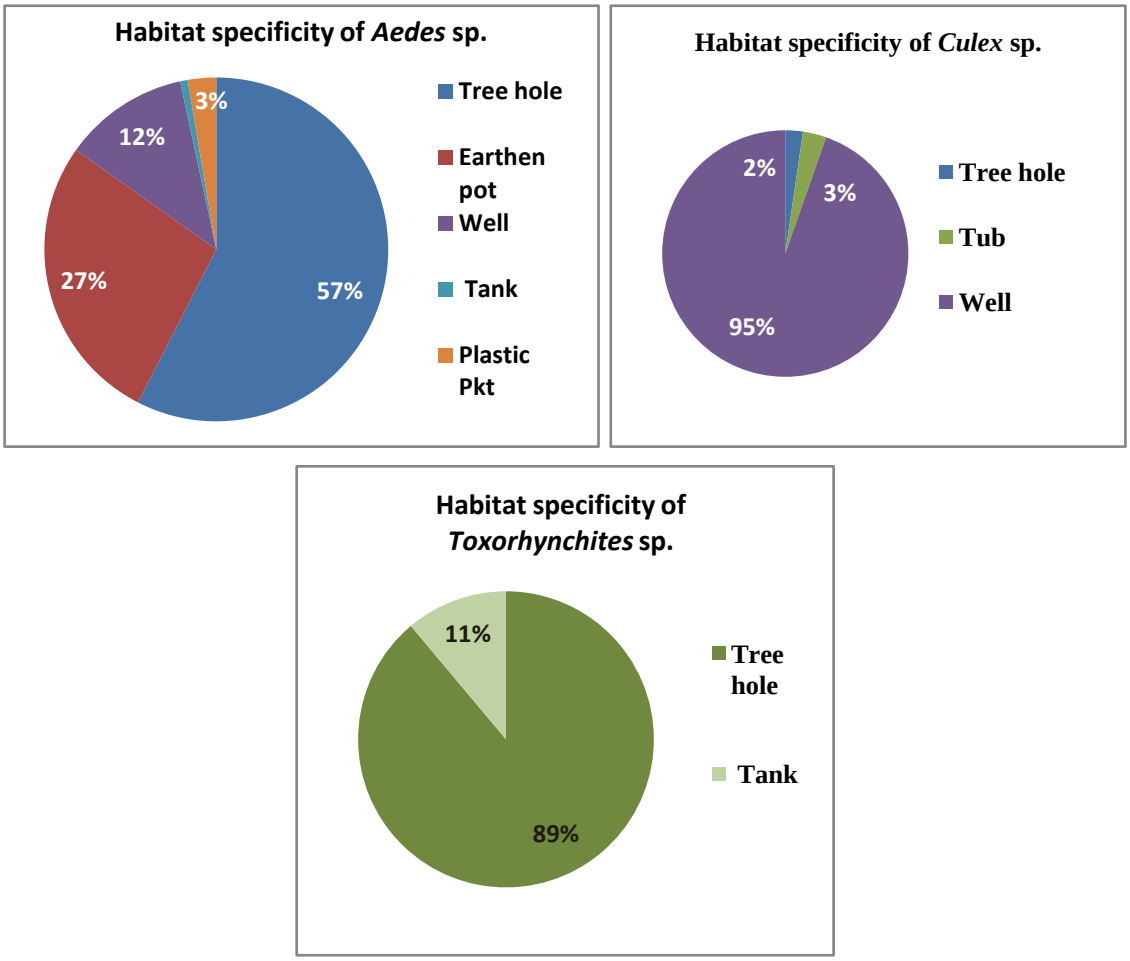


Figure 5: Habitat specificity of individual mosquito larva

Table 3: Distribution of different mosquito genus in the study area from Aug-Dec, 2019

Genus	Distribution (%)	Classification
Anopheles sp.	0-20%	Sporadic
Toxorhynchites sp.	20.1-40%	Infrequent
Culex sp.	40.1-60%	Moderate
Aedes sp.	60.1-80%	Frequent

Table 4: Relative abundance of different mosquito Genus in the study area from Aug-Dec, 2019

Genus	Relative abundance (%)	Classification
Anopheles sp.	Less than 1	Satellite species
Toxorhynchites sp.	Less than 5	sub-dominant species
Culex sp. and *Aedes* sp.	More than 5	Dominant species

In the present study, season wise habitat specificity was marked for *Aedes* sp. *Aedes* was found to have preference for tree holes and earthen pots during rainy season (August to November). But when these water sources were eliminated in winter month the eggs were mostly deposited in well water. *Culex* was found to be more numerous in well than in other oviposition sites.

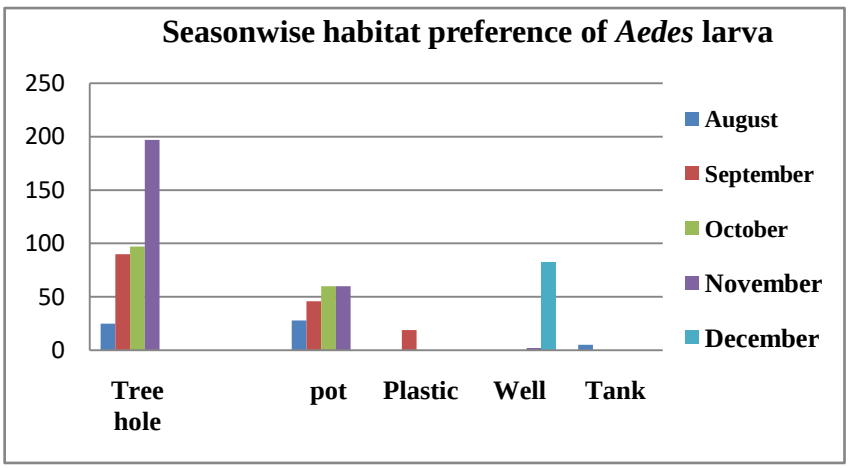


Figure 6: Season wise habitat preference of *Aedes* larvae

Discussion:

According to the report of Irrigation and waterways Directorate, Govt. of West Bengal, annual flood report, 2019, the study area had below normal rainfall in the month of June and

July. In August the average rainfall (mm) was 421.60 mm which was greater than the normal value of 340.70mm. But in September the rainfall value lowered to 322.70 mm (close to the normal value of 300.30 mm). Rainfall of early and end of October was 204.70 mm (above normal value 149.20). The monthly rainfall declined in November to 98.20mm but still the value was more than the normal value of 26.60 mm. Our observation was that as the tree hole contained water upto the month of November due to the excess rainfall in the area, larvae of *Aedes* were obtained in high number in tree hole. In December rainfall declined to 8.50 mm which is exactly the normal value of this season.

Therefore, increase in the larval density in well water can be correlated as alternative habitat choice due to drying of tree holes (Irrigation and waterways Directorate, Govt. of West Bengal, annual flood report, 2019).

In Naihati, *Aedes* and *Culex* used different breeding habitat. *Aedes* were found mostly in natural habitat like tree holes which were associated with leaf litter and organic materials and psychodid moth fly larva.The breeding sites were also under tree shades (Philbert and Ijumba, 2013). But, *Aedes* were even found in artificial container like earthen pot and plastic packets also.The non blood feeding mosquito *Toxorhynchites* are predatory larvae and preferably feeds on *Aedes* species (Zuharah *et al.,* 2015). In the study sites this species were found to coexist in treeholes with *Aedes* in the month of October and November and observed to predate on whole *Aedes* larvae. In the survey site *Toxorhynchites* were never found to be associated with *Culex* or *Anopheles* larvae in any selected habitat.

Conclusions:

From this survey it can be concluded that patterns of seasonal abundance of certain mosquito species may vary spatially and are correlated to proliferation of its breeding habitats during rainy season and its scarcity during dry season. Therefore, the breeding grounds identified should be eliminated by removal of water-holding containers around households of the study areas and proper disposal of earthen pots, plastic packets should be implemented. Well water should be covered. Blocking of tree holes and plant cavities during rainy season is necessary.

Acknowledgements:

The authors are immensely grateful to the Principal, Barasat Govt. College for the infrastructural support provided for completion of this survey work. We would also like to thank all the faculties and staffs of Department of Zoology for their cooperation and support to successfully carry out the work.

References:

Ali, N., Marjan, Khan, K., Kausar, A. (2013): Study on mosquitoes of Swat Ranizai sub division of Malakand. Pak J Zoo, 45(2):503-510.

Ali, N., Rasheed, S.B. (2009): Determination of species composition of Mosquitoes found in Palosai stream, Peshawar Pakistan. J Entomol, 31(1):47-51.

Becker, N., Pluskota, B., Kaiser, A., Schaffner, F. (2012): Exotic mosquitoes conquer the world, Arthropods as vectors of emerging diseases. Springer, pp. 31–60.

Bentley, M.D. and Day, J.F. (1989): Chemical ecology and behavioral aspects of mosquito oviposition. Annual Review of Entomology, 34: 401–421.

Carlson, J., Keating, J., Mbogo, C.M., Kahindi, S., Beier, J.C. (2004): Ecological limitations on the aquatic mosquito predator colonization in the urban environment. J Vect Ecol, 29(2): 331–9.

Irrigation and waterways Directorate, Govt. of West Bengal, annual flood report, 2019. https://wbiwd.gov.in/uploads/anual_flood_report/ANNUAL_FLOOD_REPORT_2019.pdf

Manguin, S., Boëte C (2011): Global impact of mosquito biodiversity, human vector-borne diseases and environmental change. The Importance of Biological Interactions in the Study of Biodiversity.Rijeka, Croatia: InTech open access publisher; 390pp.

National vector borne disease control programme, Directorate general of health services, ministry of health & family welfare, Government of India, 2014–15. https://nvbdcp.gov.in/

Philbert, A. and Ijumba, J.N. (2013): Preferred breeding habitats of Aedes aegypti (Diptera: Culicidae) mosquito and its public health implications in Dares Salaam, Tanzania. Journal of Environmental Research and Management, 4(10): 344-351

Rueda, L.M. (2004): Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with dengue virus transmission. Zootaxa, 589:1-60.

Rueda, L.M. (2007): Global diversity of mosquitoes (Insecta: Diptera: Culicidae) in freshwater. Freshwater animal diversity assessment. Springer, pp. 477–487.

State bureau of health intelligence, Directorate of Health services, Government of West Bengal, 2015–2016; 119–198. https://www.wbhealth.gov.in/other_files/Health%20on%20the%20March,%202015-2016.pdf

Zuharah, W. F., Fadzly N., Yusof N.A., Dieng H. (2015): Risky behaviors: Effects of Toxorhynchites splendens (Diptera: Culicidae) predator on the behavior of three mosquito species. J. Insect Sci., 15:128

FISH MARKET AT NAVLAKHA, INDORE: A STUDY

Harshita Patidar, Dharmendra Dhurve, Ashul Baghel,
Himanshu Patidar* and Prakshi Patidar
Govt. Holkar Science College, Indore (M.P.)
*Corresponding author E-mail: himanshupatidar114433@gmail.com

Abstract:

Indore is the cleanest city of India (2017–2021) having a population of 20 lakhs (2011). There are several markets in Indore, which includes fish market also; there are several different markets in Indore city out of which Navlakha fish market is 4th biggest market which includes wholesaler and retailer also. This market can be studied on Thursday. Various levels of markets can be observed where bidding/auction takes place. This study took place in the month of November to December 2021. This study has aims of studying various fish species and their various aspects. This result can be useful in highlighting the importance of fish markets in big cities to fully fill the food demands.

Keywords: Navlakha, Fish products, Nutrition, Hygienic, Indore

Introduction:

Quality places play an important role in edible fishes. It widely depends on the nutritional microbiological, biochemical and physicochemical character and it is mainly checked by sensory and instrumental methods. Fishes are well known for their various nutritional compositions: water contains 70-84%, protein 15-24%, fat 0.1-22% and 0.1% vitamin A, D, B and C and 1-2% minerals. They have been widely used as an important source of animal protein and other nutrients for human health. It has health benefits for heart disease, cancer, blood pressure etc. 300gm of raw fish flesh is sufficient to supply half of the total raw protein and fat requirement and 1/4th of the calories needed in a balanced daily diet for adult human beings (Shrivastava, 2011). It is filled with omega 3 fatty acids and vitamins D and B_2 (Riboflavin), also rich in calcium and phosphorus and it is a good source of minerals like iron, magnesium, potassium, zinc, iodine etc. Fishes in the market are available in different forms like some are in live condition, some are dead and some are in dried form. The American Heart Association recommends eating fish at least two times in a week as part of a good and healthy diet. Therefore, this study aims at studying fish market of Indore City for better understanding of fish products and their source.

Methodology:

Study area: Navlakha fish market

Location of market: Near AB Road, Navlakha, Vidya Nagar Indore.

Area of market: 684 m^2

Study duration: 1 month (from 16 Nov - 15 Dec)

Data Collection: Direct observation.

We observed that this market is held once a week on Thursday. This market is known as guruwarya haat. It opens at 1 o' clock and closes at 9:30 pm.

Figure 1: Study area Navlakha Fish Market of Indore City

Results:

In this study we have observed around 250 shops and they keep live, fresh and dried fishes. About 20 different species of fishes are brought in the market for sale.

Table 1: Table showing data of various shops

	Shop No 1	**Shop No 2**	**Shop No 3**	**Shop No 4**	**Shop No 5**
Name of Shopkeeper /Fishermen	Ashok gaud	Rakhi bai	Rajesh Verma	Akash rawal	Gagan borasi
Opening Timing of Shop	3:00 pm - 9:00 pm	2:00 pm - 8:00pm	2:30 - 9:00 pm	2:00 - 9:30 pm	3:00-9:30 pm
Fishes Supply From	Mumbai, Maharashtra	Khalghat, MP	Bilawali Indore, MP	Khajuriya, MP	Tilore, MP
Types of Fishes	Dried	Raw	Raw	Raw/fresh	Raw/fresh
Means of Transport	By truck	Tata tempo	Auto	Auto rickshaw	Pickup
Quality of Fish	Very good	Good	Good	Good	Very good

Species	Bombay duck, Dry prawns,	*Catla- catla Clarias batrachus, Xenentodon cancila, Notopterus chitala, Notopterus notopterus*	*Common carp, Pangasius, Catla – catla, Cirrhinus mrigala*	*Tilapia, sperata seenghala, Notopterus chitala, Anguilla benghalensis,*	*Rupchanda, Anabas testudineus, Pangasius, Tilapia, Common carp,*
Highest Price of Fish (Name/Prize)	600 rupee/kg - Bombay duck	180 Rs/ kg, catla catla	200 Rs/kg, common carp	300 Rs/ kg, seenghala	310 Rs/kg Tilapia
Average Per Market Selling	15-19 kg	25-30kg	20-25kg	40-50kg	50-60kg
Highest Sale in Season	Winter (nov – jan)	Winter (nov – Jan)	Winter (nov – Jan)	Winter (nov – Jan)	Winter (nov – Jan)
Hygienic Condition	Average	Good	Good	Good	Good
Gutting Facility	Not available	Available	Available	Available	Available
Electricity Facility	Not available	Not available	Not available	Not available	Not available
Shop Size	3x2 m	3x2 m	3x5 m	4x5 m	4x5 m
Fishermen Belongs From	Local Indore	Khalghat MP	Indore	Khajuriya MP	Khajuriya MP
Import	Mumbai	Narmada river Khalghat	Bilawali lake	Yashwant sagar	Pond
Shopkeeper Behavior	Excellent	Good	Good	Good	Good
Shopkeeper Vaccinated (Partially/Completed)	Completed	Completed	Completed	Completed	Completed
Source of Fishes	Marine/fresh water	Fresh water	Fresh water	Fresh water	Fresh water

These shopkeepers and wholesalers buy these fresh water fishes from ponds, rivers (Narmada) and lakes like Yashwant Sagar, Bilawali lake, Sirpur lake and Pipliyahana lake etc. Beside this Marine fishes, fresh and dried fishes are also brought from Mumbai in bulk or by

individuals. Each shopkeeper sells about 15 to 60 kg of fish in a day. Fishes available in the market are of different shape, size and weight. Prices of the fishes vary from species to species; minimum rate of fish is 100 Rs/kg and maximum rate reaches up to 600 Rs/kg. We noticed that the average size range of fishes is from 5 cm to 50 cm. Other than fishes, some aquatic organisms are also sold in the market, like crabs, shrimps etc. For preservation of a fish ice is used. Market management is well maintained, all shops have their particular place. Shopkeepers maintain hygiene in shops. Women participation is also well observed in this market.

Figure 2: Figure showing photographs of fish market

Discussion:

The results of our study showed that the fish market of Indore city caters to a large population. The different species in the market shows difference in food preferences. We have observed around 250 shops and they keep live, fresh and dried fishes. The post-harvest operations of fish provide more employment to labor than the production sector (Sathiadhas *et al.,* 1994). These shopkeepers and wholesalers buy these fresh water fishes from ponds, rivers (Narmada) and lakes like Yashwant Sagar, Bilawali lake, Sirpur lake and Pipliyahana lake etc. Beside this Marine fishes, fresh and dried fishes are also brought from Mumbai in bulk or by individuals. Each shopkeeper sells about 15 to 60 kg of fish in a day. Fishes available in the

market are of different shape, size and weight. Similar studies were done by Mahor (2011). Harvesting and marketing of fish provides enormous employment opportunities. Prices of the fishes vary from species to species; minimum rate of fish is 100 Rs/kg and maximum rate reaches up to 600 Rs/kg. Compared to the achievements in fish production, the fish marketing system is very poor and highly inefficient in India as reported by Kumar *et al.* (2008). We noticed that the average size range of fishes is from 5 cm to 50 cm. Other than fishes, some aquatic organisms are also sold in the market, like crabs, shrimps etc. For preservation of a fish ice is used. Kumar (2008) also reported the problem of domestic marketing of fish and fishery products in India. Market management is well maintained, all shops have their particular place. Shopkeepers maintain hygiene in shops. Women participation is also well observed in this market.

Acknowledgement:

The authors are very grateful to Dr. Priya Gaur for their immense help and support for conducting this study. Authors acknowledge the help received from and other scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from which the literature for this article has been reviewed and discussed.

References:

Kumar, Ganesh B., K.K. Datta, P.K. Katiha, R. Suresh, T. Ravisankar, K. Ravindranath and Muktha Menon (2008): Domestic Fish Marketing in India –Changing structure, conduct, performance and policies. Agriculture Economics Research Review, Vol. 23 Jan.-June: 345-354.

Kumar, R. (2008): Domestic Marketing of Fish and fishery products in India – opportunities and challenges. In: National workshop on Development of strategies for Domestic Marketing of Fish and fishery products held at college of fisheries sciences, Nellore, India7-8 feb.:43-48.

Mahor, R.K. (2011): A survey of fish and fisheries of the fresh water reservoir Tighra, Gwalior, Madhya Pradesh. Int Referred Res J; 2(25):49-50.

Sathiadhas, R. and R. Narayana Kumar, (1994): Price Policy and Fish Marketing System in India. Biology Education, Oct-Dec. pp 225-241.

Srivastava, C. B. L. (1999): A text book of fishery science and Indian fisheries. Allahabad: Kitab Mahal. pp101-180.

STUDY OF ABIOTIC FACTORS AND INVESTIGATION OF ZOOPLANKTONS OF SHAHANOOR WATER BODY TAHSIL ANJANGAON SURJI, DIST. AMRAVATI (M.S.)

Suwarna K. Zilpe

Department of Zoology,

Smt. Radhabai Sarda College of Arts, Commerce and Science,

Anjangaon Surji, Dist. Amravati

Corresponding author E-mail: skzilpe13@gmail.com

Abstract:

This water bodies is found in Shahanoor River near tahasil Anjangaon Surji of Amravati Dist (M.S.) India. The length is of this water body is 828 meter, Height 57.81M and the capacity of this water bodies is $1.626x10^9$ cu ft with surface area of $2.970km^{2.}$. It is mainly used for drinking, fishing and irrigation purpose. The present investigation study deals with the study of of some physico- chemicals and zooplankton abundance. The samples were collected in the morning time during July, 2019 to December, 2020 to assess various nutrient levels, zooplankton diversity and parameters such as pH, nitrates, sulphates, phosphates, C.O.D., B.O.D., water temperature , Turbidity etc. Variations in parameters were noted and it is concluded that water of the shahanoor dam is potable and it is a unique ecosystem.

Keywords: Abiotic factor, Zooplankton, Shahanoor.

Introduction:

Water pollution is one of the major problems in many parts of country. The contamination of waterbodies might lead to a change in their tropic status and render them unsuitable for various purposes. Hence regular monitoring of the physicochemical parameters is essential to determine status ofdam. Water along with its contained substance and energies, constitute an immediate environment foraquatic organism. Most of the physical and chemical features invariably have significant influencesonthe aquaticlife. Water pollution is the excess addition of harmful material, the material are harmful to the life, many workers proved that due to water polluction the quality of water is lost. Water quality of drinking water varies form time to time and place to place due to interaction of local factors due to lack of knowledge about the water quality and their effect the inhibitants are prone to diseases and health problem. Hankock (1973), APHA (1985), Khulbe (1993) worked on the water quality of various water resources.

Physicochemical parameters of any water body helps for the existence and growth of zooplankton (Hanazato and Yasuno, 1985; Bharti and Rana, 1987).

Materials and Methods:

In order to study the limnological aspects (i. e. nutrient level) of shahanoor dam, five sample spots were chosen to represent the whole waterbody. The water samples were collected from five different spots in the morning time in clean iodine treated poly vinyl chloride container and in BOD bottles to analyse the nutrient level and physio-chemical parameters as prescribed by APHA (1995). To study the zooplankton community, the sample were collected in 1000ml bottle and preserved by 5% formaldehyd and centrifused at for 15-20 minutes. The zooplankton settled at bottom was dilated to a desired concentration in such a way that they could be easily counted individually under binocular microscope. The species diversity richness of zooplankton was was calculated as per the method of APHA (2005).

Result and Discussion:

Dam/Pond constitutes an integral part of purposes urban community in respect of providing drinking water source, agriculture and fish culture purposes. However, due to unplanned urbanization, population expansion and increase in density and over exploitation for various purposes, these important aquatic resources are under severe stress leading to deterioration of water quality and deplection of aquatic biodiversity. A definite seasonal variation was evident among the various abiotic factor characteristics. In the present investigation analysis of water samples from Shahanoor dam was carried out during period from July, 2019 to December, 2020.

Biological Oxygen Demand

It indicates the present of biological matter in the water and express degree of contamination. The value of B. O. D varies from 4.3 to 24.6 mg/lit. The value of BOD was highest during monsoon and minimum in winter.

Chemical Oxygen Demand

It determines the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. During the present investigation C. O. D values range from 5.3 to 9.9 mg/lit. The maximum values noted in mansoon due to inflow of organic dead matter and minimum were found in winter.

Temperature

The average air temperature was varied in the range of 27^0C to 32^0C. The minimum value was recorded in the month of July 2019 while maximumvalue in December 2020.

Transparency

The transparency water body is mainly affected by suspended particle and indirectly influences the physio-chemical parameters. Low value of transparency was recorded during July to December.

Sulphates

Sulphates are generally present in sufficient concentration and increase the hardness of water. The average sulphate values were recorded in the range of 02.09-03.85 mg/lit. During the period of study, minimum value 01.76mg/lit. and maximum value 03.80 mg/lit was recorded.

Nitrate

Nitrate is an important plant nutrient and when present in maximum quantity is responsible for eutrophication. Higher value of nitrates was recorded July 2019 and lower values were recorded in December 2020.

pH

The determination of pH of water is important as it plays alimiting role in the growth of aquatic flora. The average range of pH was in between 7.99 to 8.46. The minimum value was found in December 2020

Total Phosphorus

The present average total phosphorus oscillated between 0.28-0.69 mg/lit. The minimum value 0.34 mg/lit. and maximum value 0.67 mg/lit. was recorded in July 2019 and December 2020 respectively.

Inorganic Phosphorus

The most significant form of inorganic phosphorus is orthophosphate is the only directly utilized form of soluble inorganic phosphorus. The average value fluctuated between 0.76-0.98 mg/lit. The lowest value was 0.09 mg/lit. and highest value was 0.92 mg/lit. in July 2019 to December 2020.

Organic Phosphorus

The average value was recorded in range of 0.69-0.77 mg/lit. The minimum and maximum values were recorded 0.85mg/lit. and 0.99 mg/lit. in July 2019 to December 2020.

The present investigation was carried out to evaluate the population of zooplankton of the lake. The diversity revealed the presence of different species. In the present study total zooplankton comprises of four groups. They are Rotifer, Protozoans, Cladocera and Copepoda (Pathak and Shastree, 1993).

Conclusion:

Further it is concluded that the levels of various abiotic factor of shahanoor dam suggest its suitablefor drinking, fish culture, agriculture purpose practiced which can be enhanced by

introducing fingerlings ofmajor carps and exotic carps. The Cladocera and Protozoans are the commonly occurrence inalmost all water bodies they represent an important like in the aquatic food chain. The high densityin summer seasons may be due to reduced water volume and their by increased concentration ofnutrients. The Copepods are major link in the aquatic ecosystem they are dominance during present study.

Table 1: Occurrence of zooplankton in the Shahanoor water body

Name of group and Species	Jul	Aug	Sep	Oct	Nov	Dec
Rotifer	+	+	-	+	+	+
Brachious Caudatus	+	-	-	+	+	+
Brachious Fioficula	-	-	+	+	+	-
Monostyla Sp.	-	+	+	+	-	-
Protozoa	+	-	+	+	+	-
Entamoeba histoylitica	-	+	+	+	-	-
Cladocera	-	+	-	-	+	-
Diaphnia Sp	+	-	+	+	+	-
Diaphenosama Sp	-	+	+	+	-	-
Copepoda	-	+	+	-	+	+
Monocyclops Sp	-	+	+	-	+	-
Ostracoda	+	-	+	+	+	-
Cypris Sp	+	-	-	+	+	+

References:

APHA (1985): Standard method for the analysis of water and waste water. APHA Washingten**.**

APHA (2005): Standard methods for the examination of water and waste water 21st Edn.Washington D.C.2005.

Bharti, D.P.S. and K.S. Rana (1987): Zooplankton in relation to abiotic components in thefortmoat of Bhartpur.Proc. Nat. Acad. Sci. India57(B):237-242.

Hanazato, T., and M Yasuno (1985): Population dynamics and production of cladoceran.zooplanktons in the highly eutrophic lake Kasumigaura. Hydrobiol. 124:13-22

Khulbe R.D. and Durgapoal A. (1993): Evolution of drinking water quality at Bhitmal national, Uttar Pradesh, Poll R S.5.21 (2): 109-111.

Pathak S. and N.K. Shastree (1993): Physicochemical Status of the lentic hydrosperher of Rukhmini and Visar Sarovar of Gaya, Bihar. Environ &Ecol. 11(1):57-66.

STUDY ON MORPHOLOGY AND LIFE CYCLE OF ROTIFER

S. G. Chhaba

Department of Zoology,

Smt. Radhabai Sarda Arts, Commerce and Science College, Anjangaon Surji

Corresponding author E-mail: sangitachhaba@gmail.com

Abstract:

Rotifers are microscopic aquatic animals of the phylum Rotifera, generally smaller than 1mm. They can be found in any water body, but also in mosses, lichens and soil, due to their ability to survive desiccation entering dormancy. Dormant stages can also act as propagules for passive dispersal. These animals are very important in evolutionary biology, as they are the most diverse and old of the 'ancient asexuals'. Rotifers act as an excellent live feed for fish and other aquatic animals. Present study deals with the morphology and life cycle of Rotifers.

Keywords: Life cycle, Morphology, Rotifers, Zooplanktons

Introduction:

Zooplanktons are one of the most important primary foods for fish larvae. Introduction of live zooplankton into a fish culture system leads to increases in the growth rate of carp species (Jha *et al.*, 2006). Plankton population is a crucial factor in developing the pond ecosystem. It is positively correlated with fish yield (Garg and Bhatnagar, 1999). Zooplankton are the major grazers of aquatic food webs, thereby acting as the principal energy gateway from primary producers to consumers at higher trophic levels, including fish, seabirds and marine mammals (Mauchline, 1998; Richardson, 2008).

The Rotifers commonly called 'Rotifera', 'Rotatoria', or 'wheel animalcules' forms an integral link in the aquatic food chain. Rotifer is the most important prey for fish and mostly used as live food. Brachionus plicatilis is a small Rotifer first developed as larval fish food in Japan in the 1950s. Rotifers are most commonly used to feed fish larvae in hatcheries around the world. Rotifers are very useful organisms as a live feed in aquaculture (Planas and Cunha, 1999). If all the conditions were maintained properly the Rotifers like B. quadridentatus need a little more than a day to double its population beginning from day-4 post culture, and thus stand out clearly as promising, reliable, and easy to culture freshwater zooplankton species (Ajah, 1997). Following features of Rotifers make them ideal feed for fish culture:

- Rotifers are planktonic in nature and their size (130-320 μm) is suitable for the first feeding of fish larvae.
- Rotifers have a rapid reproduction rate.
- Their small size and slow swimming activity make them a suitable prey for fish larvae.
- They have the ability to grow and reproduce in high density cultures.
- They are suitable for mass culture under controlled conditions.

Morphology:

Rotifers belong to the smallest group of metazoans, more than 1000 species of Rotifers were described up to now, among which Brachinous were found in abundance around Washim region and hence it was used for culture experiment. Female Rotifers are larger in size and more developed than the male Rotifers. Male Rotifers are smaller in size, they have no digestive tract and no bladder but they consist of over-proportionate single testis which is filled with sperm. The epidermal layer of Rotifer consists of a densely packed layer of keratin protein which is called as lorica, (Fukusho, 1989). The body of the Rotifer is divided into three parts that is head, trunk and foot.

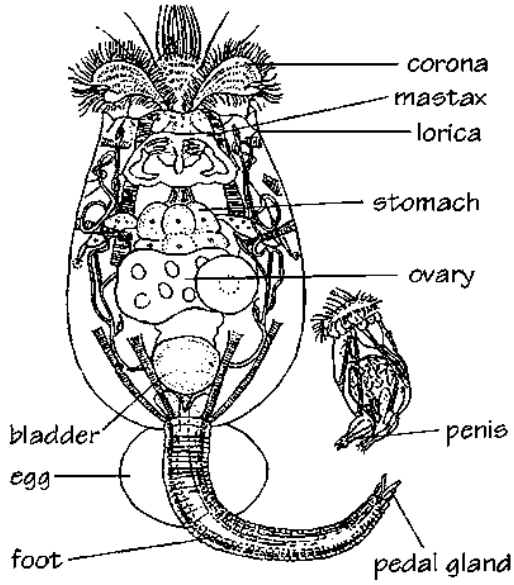


Figure 1: Morphology of Brachionus plicatilis female and male

Head:

The head region of the Rotifers consists of the rotatary organ called corona. The corona consists of numerous cilia which provide continuous wheel like motion to the organism's body and hence the Rotifers are also called as wheel animals. The corona helps in the locomotion by its continuous motion; it also facilitates the uptake of the food particles.

Trunk:

The digestive tract, execrator system and genital organs are present in the trunk of the Rotifers. The initial part digestive tract of the Rotifer consists of Mastax which is helpful in the grinding of ingested food particles.

Foot:

The foot is ring type, without any segment which ends into the one or four toes. The detail morphology of male and female Rotifer is depicted in the following figure

Life Cycle:

The total life span of Rotifer is approximately 3-5 days. The larvae developed into the adult in 0.5 to 1.5 days. The adult females start to lay eggs approximately after every four hours. Rotifers show two different modes of reproduction that is parthenogenesis and sexual reproduction.

Parthenogenesis:

During unfavorable conditions the female Rotifers undergo parthenogenesis. In parthenogenesis amictic females produce amictic (diploid, 2n chromosomes) eggs which develop and hatch into amictic females.

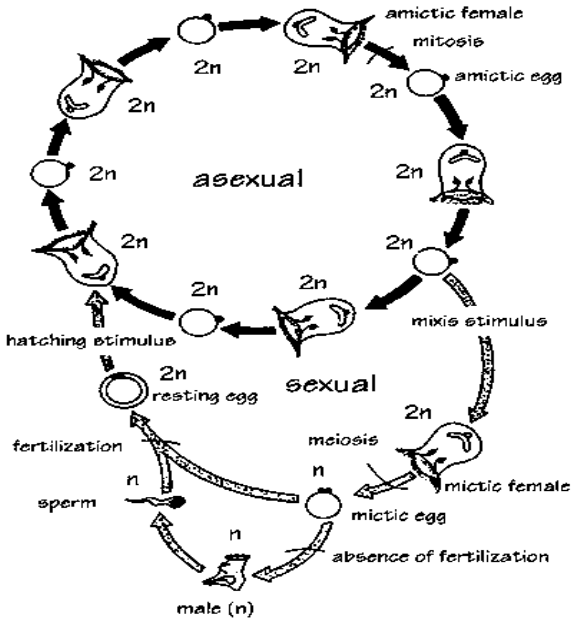


Figure 2: Life cycle of Rotifer

Sexual Reproduction:

Under the favorable conditions Rotifers undergo sexual reproduction by the fusion of male and female gametes which results in production of mictic and amictic females. The mictic females produce haploid eggs, the larvae hatched out from this unfertilized haploid eggs develop

into haploid male. Mictic eggs which hatched into males are smaller in size; on the other hand the mictic fertilized eggs are larger and have a thick, faintly granulated outer layer.

References:

Ajah, P. O. (1997): Effects of live foods, artificial feed and their combination on growth and survival of African clariid cat fish (Heterobranchus longifilis Valenciennes, 1840) larvae. The Israeli J. Aqua. –Bamidgeh. Vol. 49(4): 205- 213.

Fukusho, K. (1989): Biology and mass production of the Rotifer, Brachionus plicatilis. Int. J. Aq. Fish. Technol. Vol. 1: 232-240.

Garg, S. K. and A. Bhatnagar (1999): Effect of different doses of organic fertilizer (cow dung) on pond productivity and fish biomass in still water ponds. J. Appl. Ichthyol. Vol 15: 10-18.

Jha, P., S. Barat and C. R. Nayak (2006): A comparison of growth, survival rate and number of marketable koi carp produced under different management regimes in earthen ponds and concrete tanks. Aquacult. Int. Vol. 14 : 615-626.

Mauchline, J. (1998): The biology of Calanoid copepods. Advances in Marine Biology. Vol.33: 710.

Planas, M. and I. Cunha (1999): Larviculture of marine fish problems and perspectives. J. Aquaculture. Vol. 177: 171-190.

Richardson, A. J. (2008): In hot water; zooplankton and climate change. ICES Journal of Marine Science. Vol.65: 279-295.

BIOINSPIRED SYNTHESIS OF METALLIC NANOPARTICLES AND APPLICATIONS

Vaishali J. Badwaik
Department of Zoology,
Vidyabharti College, Seloo, Wardha 442 104, M.S. India
Corresponding author E-mail: vaishalijbadwaik@gmail.com

Abstract:

Bioinspired synthesis of metallic nanoparticles is an eye-catching approach towards green nanotechnology. Metallic nanoparticles and their synthesis have significantly increased, but involvements of toxic chemicals and energy requirement limits the alternative synthesis of nanoparticles (NPs). Whereas, a recent approach to synthesize nanoparticles from the microorganisms and plants have evolved greatly, as most of the biological entities are structurally similar to the nanomaterials (NMs). The NMs are very useful in various *in vivo* and *in vitro* biomedical research and applications, thus, the synthesis of those are in high demand. This chapter summarized the green synthesis of nanoparticles, its eco-friendly approach, along with antioxidant, antimicrobial, therapeutic and diagnostic applications.

Keywords: Green synthesis, Metallic Nanoparticles, Antimicrobial, Diagnostic Applications

Introduction:

Nanobiotechnology is a biology-based, application-oriented frontier field of a hybrid research of nanoscience and biotechnology disciplines. The nanobiotechnology has become an attractive focus in current green research towards sustainable development, but its simultaneous adverse impact needs to be studied on the same side. The various metal nanoparticles, synthesised by chemical and physical method have shown antimicrobial properties, include silver nanoparticles (AgNPs) (Duran *et al.*, 2007; Guzman *et al.*, 2009; Guzman *et al.*, 2012). Growth of Gram-positive and Gram-negative bacteria could be effectively inhibited by silver and gold nanoparticles (Lima *et al.*, 2013). Due to the optical property gold nanoparticles (AuNPs) have been used as photothermal agents for the thermal ablation of solid tumors. Gold nanorods (GNs) have also shown promising results in biosensing, drug delivery, photothermal therapy and imaging (Krishnaraj *et al.*, 2010).

In cancer therapy, ruthenium play a very important role as an anticancer agent, as it has the ability to cause apoptosis of tumor cell (Sava and Bergamo, 2009; Ang and Dyson, 2006).

Similarly, about 106 isotope of Ru are being used in radiotherapy of malignant eye cells (Singh *et al.*, 2014).

However, the numbers of chemicals have been used in the synthesis of nanoparticles which becomes toxic solvents. It limits the potential use of nanoparticles on human welfare and biomedical application. Therefore a "green synthesis of NPs" has become the most demanding for non-toxicity (Li *et al.*, 2011). The synthesis of metallic nanoparticles from biological agents is commercial need. It is very challenging to develop an environment-friendly and inexpensive synthesis of NPs. Many organisms and plants have evolved to synthesize NPs and therefore have potential use in many fields (Pantidos and Horsfall, 2014).

Many of the biological processes performed in the nanometer-scale regime. The field of nanotechnology and biology can reveal issues related to medical field i.e. health and medicine. In different types of cancer treatment, drugs used includes polymer nanoparticles (Chan and Nie, 1998). Nanotechnology nowadays became the most significant tool in medical science like imaging (Farokhzad, 2006), delivery systems (Roy *et al.*, 1999), targeted drug delivery (Langer 2001), sensing (Vaseashta, 2005), gene and artificial implants (Dahoumane, 2016.).

This chapter will focus on providing an overview of green synthesis of metallic nanoparticle, its eco-friendly approach, microbial, environmental, therapeutic and diagnostic application.

Eco-friendly approach in nanomaterial fabrications

Green synthesis is the eco-friendly method of NPs synthesis. Green synthesis of metallic nanoparticles has many applications like antimicrobial, antioxidant and catalytic activity (Khan *et al.*, 2015). It is an eco-friendly metallic reduction method requires low energy and is very cost-effective in contrast to the chemical synthesis which requires high energy inputs and highly toxic reductants (Fig.1) (Sachlos *et al.*, 2006; Husen and Siddiqi, 2014; Patel *et al.*, 2015; Siddiqi and Husen, 2016).

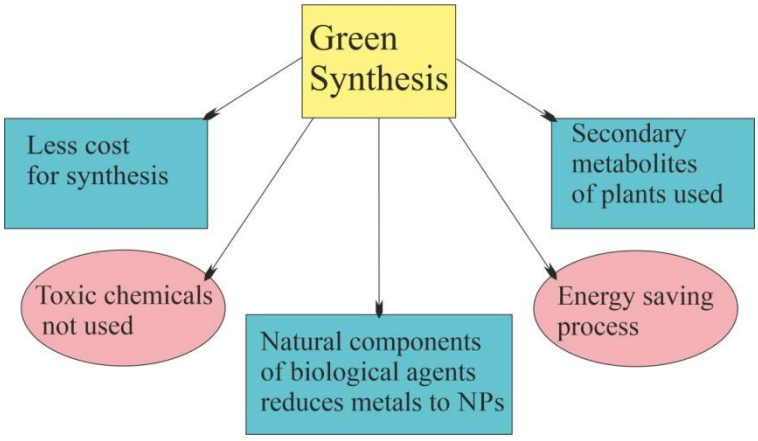


Figure 1: Advantages of green synthesis method

Table 1: Plant mediated synthesis of gold nanoparticles

Sr. No	Scientific name	Common name	Characterization	Size (nm)	Reference
1	*Bacopa monnieri*	Valaarai	UV–vis spectro- photometer, TEM, FTIR, TGA, XRD	3–45	Babu *et al.*, 2013
2	*Terminalia catappa*	Country-almond	UV-Vis spectroscopy, XRD, FTIR,TEM	10–35	Ankamwar, 2010
3	*Citrus limon, Citrus reticulata* and *Citrus sinensis*	Sweet orange	UV–visible spectra, TEM, XRD, SAED	15–80	Kumar *et al.*, 2016
4	*Tagetes erecta*	Marigold	UV-visible, HRTEM	30 −50	Krishnamoorthy *et al.*, 2009
5	*Mangifera indica*	Mango	UV–vis, TEM, XRD.	~ 20	Philip, 2010
6	*Vitis vinifera*	Grape	UV–visible spectra, TEM, XRD, FTIR	10–17	Ismail *et al.*, 2014
7	*Acacia nilotica*	Prickly acacia	UV–vis, FT-IR, XRD, TEM	10–50	Emmanuel *et al.*, 2014
8	*Abutilon indicum*	Thuthi	UV-visible spectroscopy, TEM, GC-MS and FTIR, ZETA	1–20	Mata *et al.*, 2016
9	*Pistia stratiotes* L	Arum	UV–visible spectroscopy, EDAX, SEM, TEM	2–40	Anuradha *et al.*, 2015
10	*Cucurbita pepo*	Pumpkin	UV-vis spectroscopy, TEM, DLS	600–800	Gonnelli *et al.*, 2015
11	*Butea monosperma*	Parasu	UV visible spectroscopy, XRD, TEM, DLS, FTIR	20–80	Patra *et al.*, 2015
12	*Abelmoschus esculentus*	Lady's fingers	UV–visible spectroscopy, XRD, FTIR, AFM, FESEM and EDX	45–75	Jayaseelan *et al.*, 2013
13	*Hibiscus rosa-sinensis*	China rose	UV–vis spectroscopy, TEM, FTIR	16–30	Yasmin *et al.*, 2014
14	*Ficus benghalensis*	Banyan	UV-Spec, FTIR, TEM, XRD, SPR,	2 -100	Francis *et al.*, 2014
15	*Amaranthus spinosus*	Spiny pigweed	UV-Vis, TEM, XRD, FT-IR, EDX,	10-74	Das *et al.*, 2012
16	*Euphorbia hirta*	Pill-bearing spurge	TEM, XRD, EDAX, AFM	50	Annamalai *et al.*, 2013
17	*Terminalia arjuna*	Arjuna	UV–visible, FTIR, XRD, TEM, AFM	20 - 50	Gopinath *et al.*, 2013
18	*Hibiscus sabdariffa*	Hibiscus	UV–vis spectroscopy, XRD, FTIR, and XPS, TEM	10–60	Mishra *et al.*, 2016
19	*Mimosa pudica*	Sensitive plant	UV–vis, FT-IR, XRD, HR-TEM,	12.5	Suganya *et al.*, 2016

20	*Ocimum sanctum*	Vernacular	UV−vis-NIR, TEM, GC−MS, HRTEM and SAED	10–300	Manoj *et al.,* 2015
21	*Azadirachta indica* L	Neem	TEM, DLS, SEM, FTIR, XRD, UV-vis near-infrared spectra	15–18	Bindhani *et al.*, 2014

Table 2: Green synthesis of metallic nanoparticles and their application

Sr. No.	Plant origin	Nanoparticle	Applications	References
1	*Aloe barbadensis miller* (Aloe vera).	Gold and silver	Cancer hyperthermia, optical coatings	Chandran *et al.,* 2006
2	*Acalipha indica*	Silver	Antibacterial activity against water borne pathogen	Krishnaraj*et al.,* 2010
3	*Azadirachta indica* (neem).	Gold, silver and silver-gold alloys	Remediation of toxic metals	Shankar *et al.,* 2004
4	*Coriandrum sativum* (coriander).	Gold	Photothermal therapy, drug delivery, tissue and tumour imaging	Narayanan *et al.,* 2008
5	*Eucalyptus citriodora* (neelagiri).	Silver	Antibacterial	Ravindra *et al.,* 2014
6	*Garcinia mangostana* (mangosteen)	Silver	Antimicrobial activity against *E.coli* and *S. aureus*	Veerasamy*et al.,* 2011
7	*Mentha piperita* (pepermint).	Silver	For killing microbes	Parashar *et al.,* 2009
8	*Morus* (mulberry)	Silver	Antimicrobial activity against *E.coli* and *S. aureus*	Singh *et al.,* 2017
9	*Ocimum sanctum* (tulsi: root extract).	Silver	Catalytic reduction	Singh *et al.,* 2018
10	Pear fruit extract	Gold	Catalysis, biosensing	Ghodake *et al.,* 2010
11	*Tanacetum vulgare* (tansy fruit)	Gold and Silver	Antibacterial, sensors	Dubey *et al.,* 2009

Nanoparticle production from microbes such as bacteria, actinomycetes, fungi, algae, viruses, and yeast is an environment-friendly, non-toxic, inexpensive and reliable green approach. Green synthesis of nanoparticles is in an aqueous environment with minimum costs and low energy requirement it can be easily scaled up to higher level (Tiple *et al.*, 2020).

Phyto/biosynthesis of Nanomaterial

Phyto/biosynthesis of the nanoparticle is an environment-friendly way of synthesis compared to the chemical or physical method. Nowadays, metallic nanoparticles are being synthesized biologically, as the methods do not require expensive, harmful and toxic chemicals for its synthesis. The plants are well-known for the nullification of metal-borne pollutants as they have the potential of reduction and detoxification. Number of secondary metabolites present in the plant extract such as enzymes, polymers, flavanoid and organic acid, acts as reducing agents for bioreduction of metal ions into nanoparticles (Iravani *et al.,* 2011; Makarov *et al.,* 2014; Siddiqi *et al.,* 2016; Park *et al.,* 2016; Nadaroglu *et al.,* 2017). The nanoparticles synthesized by the algae extract may have an antimicrobial property and it does not produce any toxic chemicals during the synthesis (Siddiqi *et al.,* 2016; Karaduman *et al.,* 2017).

Metallic nanoparticles are synthesised by plants *in vivo* by reducing metal salts (Parashar *et al.* (2009). Zinc, cobalt, nickel and copper nanoparticles are synthesised by mustard (*Brassica juncea*), alfalfa (*Medicago sativa*), and sunflower (*Helianthus annuus*) in vivo (Marchiol, 2012). Some metallic nanoparticles synthesise by plants and their application listed in table 2.

Bacterial synthesis of Nanoparticles

Some bacteria are immunised to suppress the toxicity of metals. These bacteria have a natural ability to synthesize nanoparticle with this characteristic bacteria can also prefer *ex-situ* synthesis of nanoparticles. For the synthesis of nanoparticles, metal ions can be reduced and precipitated. This becomes possible through the use of biochemical pathways of some biomolecules present in the bacteria (Korbekandi *et al.,* 2009; Gao *et al.,* 2014). Filamentous gram-positive bacteria Actinobacteria perform the production of antibiotics and due to their detoxification properties, nanoparticles are antibacterial, antifungal, anti-cancerous and antioxidant (Manivasagan *et al.,* 2016; Nadaroglu *et al.,* 2017).

Bacteria reduce metal ions for the preparation of NPs (Iravani, 2011). The variety of bacterial species are utilised for the synthesis of NPs. The nanoparticles synthesis by bacteria is widely accepted because of easy genetic engineering and relative ease of bacterial genome (Thakkar *et al.,* 2016). Nanoparticles synthesis by some bacteria and their applications are given in flowchart (fig. 2).

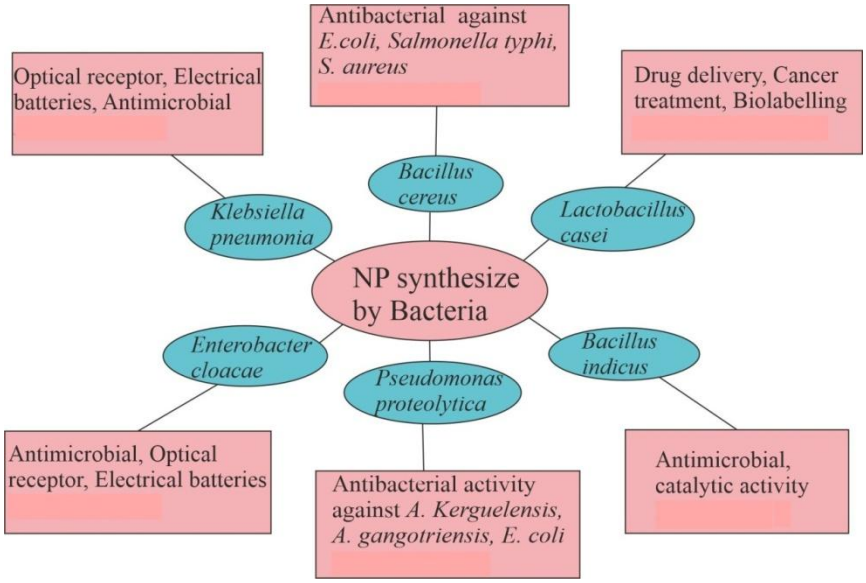


Figure 2: Synthesis of metallic NPs from bacteria and their applications (Ahmad *et al.*, 2010; Sunkar et al,. 2012; Korbekandi *et al.*, 2012; Fu M *et al.*, 2014; Shivaji *et al.*, 2011)

Fungul synthesis of Nanoparticle

As compared to bacteria, fungi can synthesize larger amounts of nanoparticles (Mohanpuria *et al.*, 2008). The enzymatic component on the fungal cell surface is responsible for the synthesis of nanoparticles (Narayanan and Sakthivel, 2011). The number of fungal species responsible for synthesizing AgNPs listed in the flowchart (fig 3).

Characterization of green synthesized Nanoparticles

Because of the size of nanoparticles, it is a big challenge for everybody to cote the characters of nanoparticles. With UV-Vis Spectral analysis, the synthesis of silver nanoparticles from different sampling was confirmed earlier (Mallikarjuna *et al.*, 2011). Singh and Jain (2014) observed the surface plasmon resonance of silver nanoparticles synthesized by onion extract (*Allium cepa*) occurred at 416nm. Dynamic light scattering (DLS) technique is used to determine the nanoparticle distribution profile on the basis of size. Singh and Jain (2014) synthesize silver nanoparticle by *Ficus benghalensis* and analyse its distribution profile on the basis of size. Transmission Electron Microscopy (TEM) gives imaging of ultrathin section of the sample. The electron is passing through the specimen. The image form can be magnified at the nanoscale and focused onto an imaging device. Singh and Jain (2011) analyzed the biologically synthesized gold nanoparticles by treating the chloroauric acid solution with *F. benghalensis* leaf extract. Silver nanoparticles synthesized from *Ocimum* leaf and its morphology was spherical (Mallikarjuna *et al.*, 2011). X-Ray Diffraction analysis is one of the best methods for the study of nanomaterial. It provides information on structure, peak intensity, position and width of

nanomaterials. A drop coated with a thin film of nanomaterials is prepared on glass or on other suitable substrates for the X-ray diffraction (XRD) analysis.Fourier transform infrared spectroscopy (FTIR) is an important technique to identify biomolecules for stabilization of green synthesizes nanomaterials. FTIR is a powerful tool for understanding the role of surface functional biological groups in metal interaction.

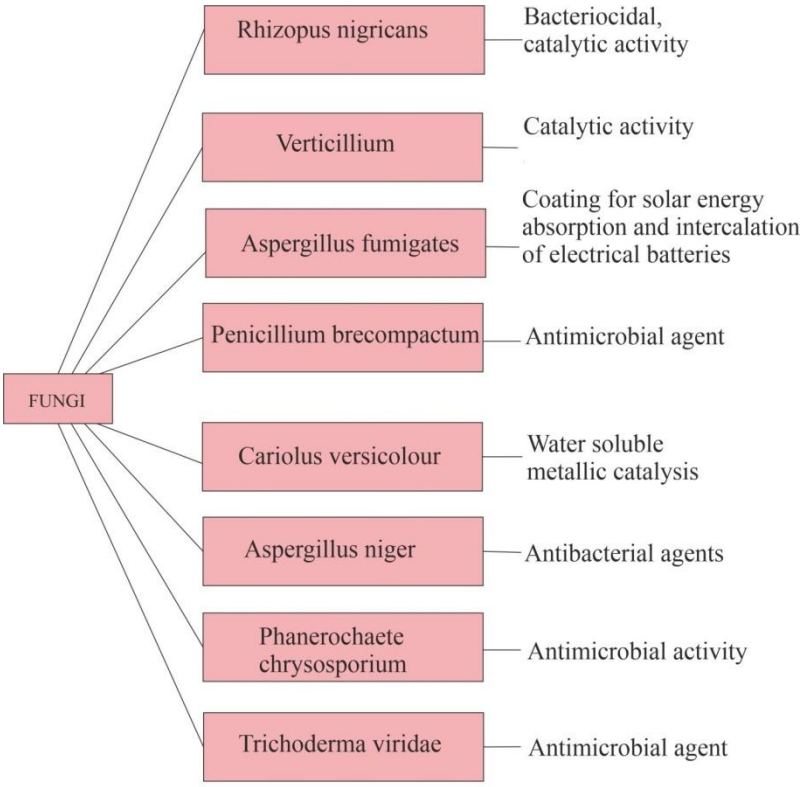


Figure 3: Synthesis of nanoparticles from fungus and their application (Ravindra *et al.*, 2014; Mukharjee *et al.*, 2001; Bhainsa *et al.*, 2006; Shaligram *et al.*, 2009; Sanghi *et al.*, 2009; Gade *et al.*, 2008; Vigneshwaram at el., 2007; Fayaz *et al.*, 2010)

The therapeutic and diagnostic application

'Nanomedicine' term refers to treatment, monitoring, diseases control and diagnosis by nanotechnology. Recent Studies on new targeted nanoparticle contrast agents for early characterization of atherosclerosis and cardiovascular pathology at the cellular and molecular levels might represent the next frontier for combining imaging and rational drug delivery to facilitate personalized medicine (Lanza *et al.,* 2002). The number of disease diagnostic nanodevices and therapy monitoring nanodevices are very efficient in improving patient's quality of life. Nanorobots are gifts for early diagnosis of diseases like cancer and Alzheimer's disease.

Nanoparticles coated with quantum dots can glow when it is exposed to ultra-violet light. When such NPs injected into the patient body, it seeps into a cancer tumour. The doctors can see the glowing tumours. Advanced research in physical chemistry, computer engineering, biochemistry, and surface microscopy gives the capability for understanding and development of NPs with different modifications at the atomic level. Nanoparticles could be very helpful in regenerating the injured nerves. The rapid evolution of this new science and the opportunities for its application promise that nanotechnology will become one of the dominant technologies of the 21st century (Singh *et al.,* 2008).

The early detection approaches for neurodegenerative diseases were the Bio-barcode assay (BCA) and Localized Surface Plasmon Resonance (LSPR) technology (Haes *et al.,* 2002, Nam *et al.,* 2003). For the effective treatment of many diseases, the most prevailing problem is early detection. Nanotechnology becomes the basis for early detection of Alzheimer's diseases. Improved understanding of brain functioning, better diagnosis and treatment for neurodegenerative diseases like Alzheimer's is offered by nanotechnology (Singh *et al.,* 2008).
The conventional diagnostic methods are slow for getting results in contrast there is need of rapid detection of pathogenic microbes at caring centres. With Nanoparticle-based bioassay, the single bacterium can be detected within 20 min (Zhao *et al.,* 2004). Silver nanorods have the ability to amplify signals, for detecting trace level of viruses with specificity (Shanmukh *et al.,* 2006).

Remediation and environmental application of green synthesized nanoparticles

The number of microorganisms becomes resistant to antiseptic and antibiotic (Korbekandi *et al.,* 2009). Various studies have been carried out to ameliorate antimicrobial functions. *In vitro* studies prove that metallic nanoparticle creates an obstacle in the metabolism of microbial species (Dizaj *et al.,* 2014). Nanoparticles have the ability to develop multiple mechanisms to fight against drug-resistant microbes. To overcome this issue; microbes should genetically alter. But biologically simultaneous multiple gene mutations are unlikely to occur (Pelgrift *et al.,* 2013). Truncated nanoparticles are very reactive because, high atom densities influence the antimicrobial activity (Singh *et al.,* 2018). Zinc nanoparticles are responsible for the synthesis of reactive oxygen species (ROS). Reactive oxygen species directly effectson the membrane and make it non-functional. It also damages microbial nucleoid and stops its replication. It is responsible for the protein and enzyme denaturation. Zn ions enter into the microbial cell and affect the metabolism of microbes (Fig. 4) (Buzea and Pacheco, 2007).

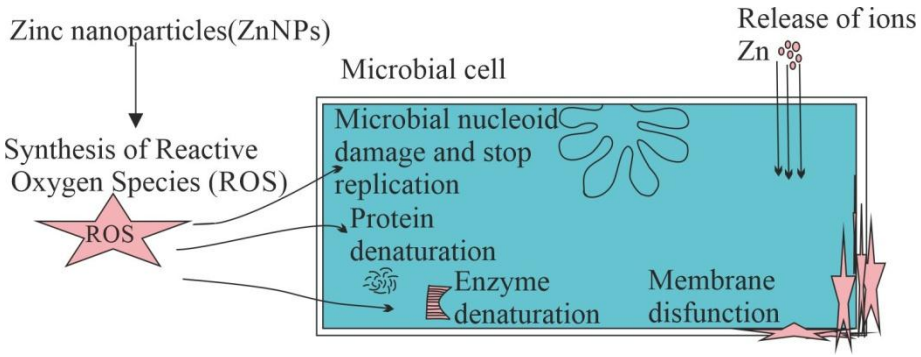


Figure 4: Effect of ROS on microbial cell synthesise by ZnNPs (Dizaj *et al.*, 2014)

Future Prospect:

The nanoparticles synthesise by natural resources are more stable and reliable than the chemical method. The use of microorganism and plants for the synthesis of (novel) NPs from the various ecosystems need to be compared and checked. Evaluation of different aspects like genetic stability, variability, biotic and abiotic factors and microorganism used for the synthesis of NPs.

Conclusion:

The numbers of biological entities and plant extracts have been used to synthesize metal nanoparticles by green synthesis. Green synthesis of nanoparticles is an Eco-friendly way that minimizes the side effects over the chemically synthesised NPs. This Green synthesis of nanoparticles haveantibacterial, antifungal, anti-cancerous and antioxidant because of its detoxification property. Plants have a great property of reduction and detoxification. The number of secondary plant metabolites is acts as reducing agents for bioinduction of metal ions into nanoparticles. The disease diagnostic and therapy monitoring nanodevices are very efficient in improving patient's quality of life. They also affect the behaviour and interaction with their surroundings. Future aspects should focus on obtaining nanoparticles with minimum toxicity, less use of energy and more catalytic activity, antimicrobial effects at its maximum level. Because of this reason, synthesizing metallic nanoparticles, especially by non-toxic green synthesis methods, which are used in many application fields such as cancer treatment, drug transport, biosensor construction is of great importance today.

Acknowledgements

The author wish to acknowledge Vidyabharti College Seloo, Wardha for providing facilities and encouragement.

References:

Ahmad, N.; Sharma, S.; Alam, M.K.; Singh, V.N.; Shamsi, S.F.; Mehta, B.R.; Fatma, A. Rapid synthesis of silver nanoparticles using dried medicinal plant of basil. *Colloids Surf. B Biointerfaces*,2010, 81, 81–6. [https ://doi.org/10.1016/j.colsu rfb.2010.06.029]

Ang WH, Dyson PJ. Classical and non-classical ruthenium-based anticancer drugs: Towards targeted chemotherapy. European Journal of Inorganic Chemistry. 2006;20:4003- 4018. DOI: 10.1002/ejic.200600723

Ankamwar B, Biosynthesis of gold nanoparticles (Green-gold) using leaf extract of Terminalia catappa, E-J. Chem. 7 (2010) 1334–1339, http://dx.doi.org/10.1155/2010/745120.

Annamalai A, V.L.P. Christina, D. Sudha, M. Kalpana, P.T.V. Lakshmi, Green synthesis, characterization and antimicrobial activity of Au NPs using Euphorbia hirta L. leaf extract, Colloids Surf. Biointerfaces 108 (2013) 60–65, http://dx.doi.org/10.1016/j.colsurfb.2013.02.012.

Anselmo and Mitragotri., 2016

Anuradha J, T. Abbasi, S.A. Abbasi, An eco-friendly method of synthesizing gold nanoparticles using an otherwise worthless weed pistia (Pistia stratiotes L.), J. Adv.Res. 6 (2015) 711–720, http://dx.doi.org/10.1016/j.jare.2014.03.006.

Babu P.J., P. Sharma, S. Saranya, U. Bora, Synthesis of gold nanoparticles using ethonolic leaf extract of Bacopa monnieri and UV irradiation, Mater. Lett. 93 (2013) 431–434, http://dx.doi.org/10.1016/j.matlet.2012.11.034.

Bhainsa, K.C.; D'Souza, S.F.Extracellular biosynthesis of silver nanoparticles using the fungus Aspergillus fumigatus. *Colloids Surf. B Biointerfaces*, 2006, 47,160–164. [https ://doi.org/10.1016/j.colsu rfb.2005.11.026]

Buzea, C.; Pacheco, R.K. Nanomaterials and nanoparticles: sources and toxicity. *Biointerphases*,2007, 2(4), MR17–MR71.

Chan, W.C.;Nie, S. Quantum Dot Bioconjugates for Ultrasensitive Nonisotopic Detection Science,1998, 281(5385), 2016-2018

Chandran, S.P.; Chaudhary, M.; Pasricha, R.; Ahmad, A.; Sastry, M. Synthesis of gold nanotriangles and silver nanoparticles using aloe vera plant extract. *Biotechnol Prog.*,2006, 22(2), 577-583. [https ://doi.org/10.1021/bp050 1423]

Dahoumane, S.A.; Yéprémian, C.; Djédiat, C.; Couté, A.; Fiévet, F.; Coradin, T.; Brayner, R. Improvement of kinetics, yield, and colloidal stability of biogenic gold nanoparticles using living cells of *Euglena gracilis* microalga. *J. Nanoparticle Res.*,2016,18(3), 7-9. [https ://doi. org/10.1007/s1105 1-016-3378-1]

Das, N. Gogoi, U. Bora, Green synthesis of gold nanoparticles using Nyctanthes arbortristis flower extract, Bioprocess Biosyst. Eng. 34 (2011) 615–619, http://dx. doi.org/10.1007/s00449-010-0510-y

Dizaj, S.M.; Lotfipour, F.; Barzegar-Jalali, M.; Zarrintan, M. H.; Adibkia, K. Antimicrobial activity of the metals and metal oxide Nanoparticles.*Mater Sci. Eng. C,*2014, 44,278–84.

Dubey, M.;Bhadauria, S.;Kushwah, B.S. Green synthesis of nanosilver particles from extract of *Eucalyptus hybrida* (Safeda) leaf. *Dig. J.Nanomater Biostruct*., 2009, 4,537–43.

Durán, N.;Marcato, P.D.; De Souza, D.I.H.; Alves, O.L.; Esposito, E.Antibacterial Effect of Silver Nanoparticles Produced by Fungal Process on Textile Fabrics and Their Effluent Treatment. *J. Biomed.Nanotech*., 2007, 3: 203-208

Emmanuel, C. Karuppiah, S.M. Chen, S. Palanisamy, S. Padmavathy, P. Prakash, Green synthesis of gold nanoparticles for trace level detection of a hazardous pollutant (nitrobenzene) causing Methemoglobinaemia, J. Hazard. Mater. 279 (2014) 117–124, http://dx.doi.org/10.1016/j.jhazmat.2014.06.066.

Farokhzad, O.C.; Cheng, J.; Teply, B.A.; Sherifi, I.; Jon, S.; Kantoff, P.W.; Richie, J.P.; Langer, R. Targeted nanoparticle-aptamer bioconjugates for cancer chemotherapy in vivo. *Proc.Natl. Acad. Sci. USA*.2006,103(16), 6315-20.

Fayaz, A.M.; Balaji, K.; Girilal, M.; Yadav, R.; Kalaichelvan, P.T.; Venketesan, R. Biogenic synthesis of silver nanoparticles and their synergistic effect with antibiotics: a study against gram-positive and gram-negative bacteria. *NanomedNanotechnolBiol Med.,* 2010, 6(1),103-109.[https ://doi.org/10.1016/j.nano..04.006]

Francis *et al.*, (2014)

Fu, P.P.; Xia, Q.; Hwang, H.M.; Ray, P.C.; Yu, H. Mechanisms of nanotoxicity: generation of reactive oxygen species. J. Food Drug Anal.,2014, 22, 64-75.

Gade, A.K.; Bonde, P.; Ingle, A.P.; Marcato, P.D.; Duran, N.; Rai, M.K. Exploitation of Aspergillus niger for synthesis of silver nanoparticles. *J.Biobased Mater Bioenergy*,2008, 2, 243–247. [https ://doi.org/10.1166/jbmb.2008.401]

Gao, Y.; Wei, Z.; Li, F.; Yang, Z.M.; Chen, Y.M.; Zrinyi, M.; Osada, Y. Synthesis of a morphology controllable Fe3O4 nanoparticle/hydrogel magnetic nanocomposite inspired by magnetotactic bacteria and its application in H_2O_2 detection. *Green Chem.*,2014, 16,1255–61. [https://doi:10.1039/c3gc41535j]

Ghodake, G.S.; Deshpande, N.G.; Lee, Y.P.; Jin, E. Pear fruit extract-assisted room-temperature biosynthesis of gold nanoplates. *Colloids Surf. B Biointerfaces,* 2010, 75, 584–9. [https ://doi.org/10.1016/j.colsu rfb.2009.09.040]

Gonnelli, F. Cacioppo, C. Giordano, L. Capozzoli, C. Salvatici, M.C. Salvatici, I. Colzi, M. Del Bubba, C. Ancillotti, S. Ristori, Cucurbita pepo L. extracts as a versatile hydrotropic source for the synthesis of gold nanoparticles with different shapes, Green. Chem. Lett. Rev. 8 (2015) 39–47, http://dx.doi.org/10.1080/17518253.2015.1027288

Gopinath K, K.S. Venkatesh, R. Ilangovan, K. Sankaranarayanan, A. Arumugam, Green synthesis of gold nanoparticles from leaf extract of Terminalia arjuna, for the enhanced mitotic cell division and pollen germination activity, Ind. Crops Prod. 50 (2013) 737–742, http://dx.doi.org/10.1016/j.indcrop.2013.08.060.

Guzmán, M.; Jean, G.D; Stephan, G. Synthesis of silver nanoparticles by chemical reduction method and their antibacterial activity. *Int. J. Chem. Biomol. Eng.,* 2009, 2: 104-111.

Guzman, M.;Dille, J.; Godet, S. Synthesis and antibacterial activity of silver nanoparticles against gram-positive and gram-negative bacteria. *Nanomed.: Nanotech. Biol. Med.*, 2012, 8, 37-45.

Haes, A.J.; Van Duyne, R.P. A Nanoscale Optical Biosensor: Sensitivity and Selectivity of an Approach Based on the Localized Surface Plasmon Resonance Spectroscopy of Triangular Silver Nanoparticles. *J. Am. Chem. Soc.*, 2002,124(35),10596-10604.

Husen, A.; Siddiqi, K.S. Plants and microbes assisted selenium nanoparticles: characterization and application. *J.Nanobiotechnol*, 2014, 12, 28.

Iravani, S. Green synthesis of metal nanoparticles using plants. *Green Chemistry*,2011,13(26), 38–50. [https://doi:10.1039/c1gc15386b]

Ismail, M.M.H. Khalil, F.A. Al Seif, F. El-magdoub, A.N. Bent, A. Rahman, U.S.D. Al, Biosynthesis of gold nanoparticles using extract of grape (Vitis vinifera) leaves and seeds, Progress. Nanotechnol. Nanomater. 3 (2014) 1–12.

Jayaseelan, R. Ramkumar, A.A. Rahuman, P. Perumal, Green synthesis of gold nanoparticles using seed aqueous extract of Abelmoschus esculentus and its antifungal activity, Ind. Crops Prod. 45 (2013) 423–429, http://dx.doi.org/10.1016/j.indcrop.2012.12.019

Karaduman, I.; Güngör, A.A.; Nadaroğlu, H.; Altundaş, A.; Acar, S. Green synthesis of gamma-Fe_2O_3 nanoparticles for methane gas sensing. *J, Mater. Sci-Mater. El.*,2017, 28(21), 16094-16105.

Khan, M.; Al-Marri, A.H.; Khan, M.; Shaik, M.R.; Mohri, N.; Adil, S.F.; Kuniyil, M.; Alkhathlan, H.Z.; Al-Warthan, A.; Tremel, W.; Tahir, M.N. Green approach for the effective reduction of graphene oxide using *Salvadorapersica* L. root (Miswak) extract. Nanoscale Res. Lett., 2015,10,1–9. [https ://doi.org/10.1186/s1167 1-015-0987-z]

Korbekandi, H.;Iravani, S.; Abbasi, S. Production of nanoparticles using organisms. Crit. Rev. Biotechnol., 2009,29, 279– 306. [https://doi:10.3109/07388550903062462]

Krishnamoorthy G, M.M. Shabi, D. Ravindhran, S. Uthrapathy,V.G. Rajamanickam, G.P. Dubey, Nardostachys jatamansi: cardioprotective and hypolipidemic herb, J. Pharm. Res. 2 (2009) 574–578.

Krishnaraj, C.; Jagan, E.G.; Rajasekar, S.; Selvakumar, P.; Kalaichelvan, P.T.; Mohan, N.J.C.S.B.B. Synthesis of silver nanoparticles using Acalyphaindica leaf extracts and its antibacterial activity against water borne pathogens. *Colloids Surf. B Biointerfaces*, 2010, 76: 50-56.

Kumar B, K. Smita, L. Cumbal, J. Camacho, E. Hernández-Gallegos, M. De Guadalupe Chávez-López, M. Grijalva, K. Andrade, One pot phytosynthesis of gold nanoparticles using Genipa americana fruit extract and its biological applications, Mater. Sci. Eng. C. 62 (2016) 725–731, http://dx.doi.org/10.1016/j.msec.2016.02.029

Langer, R. Drug delivery. Drugs on target. *Science,* 2001, 293(5527),58-9.

Lanza, G.M.; Yu, X.; Winter, P.M.;Abendschein, D.R.;Karukstis, K.K.; Scott, M.J.;Chinen, L.K.;Fuhrhop, R.W.; Scherrer, D.E.; Wickline, S.A.Targeted antiproliferative drug delivery to vascular smooth muscle cells with a magnetic resonance imaging nanoparticle contrast agent: implications for rational therapy of restenosis. Circulation, 2002,106(22), 2842-2847.

Li, X.; Xu, H.; Chen, Z.S.; Chen, G. Biosynthesis of Nanoparticles by Microorganisms and Their Applications.*J.Nanomat.*,2011, 1-16

Lima, E.; Guerra, R.; Lara, V.; Guzmán, A. A Gold nanoparticles as efficient antimicrobial agents for Escherichia coli and Salmonella typhi. *Chem. Cent*. J., 2013, 7: 11.

Makarov, V.V.; Love, A.J.; Sinitsyna, O.V.; Makarova, S.S.; Yaminsky, I.V.; Taliansky, M.E.; Kalinina, N.O. "Green" Nanotechnologies: Synthesis of Metal Nanoparticles Using Plants. *Acta Naturae*,2014, 6,35–44.

Mallikarjuna, K.; Narasimha, G.; Dillip, G.R.; Praveen, B.; Shreedhar, B.; Lakshmi, C.S.; Reddy, B.V.S.; Raju, B.D.P. Green Synthesis of Silver Nanoparticles Using Ocumum Leaf Extract and their Characterization. *Digest J.Nanomat.Biostru.*,2011, 6, 181186.

Manivasagan, P.; Venkatesan, J.; Sivakumar, K.; Kim, S.K. Actinobacteria mediated synthesis of nanoparticles and their biological properties: A review. *Crit. Rev. Microbio.*,2016, 42, 209–21. [https://doi:10.3109/1040841x.2014.917069]

Manoj, V. Vishwakarma, Green Synthesis and spectroscopic characterisations of gold nanoparticles using invitro grown hypericin rich shoot cultures of Hypericum hookerianum, Int. J. ChemTech Res. 8 (2015) 194–199.

Mata R, J.R. Nakkala, S.R. Sadras, Polyphenol stabilized colloidal gold nanoparticles from Abutilon indicum leaf extract induce apoptosis in HT-29 colon cancer cells, Colloids Surf. B: Biointerfaces 143 (2016) 499–510, http://dx.doi.org/10.1016/j.colsurfb.2016.03.069.

Mishra P, S. Ray, S. Sinha, B. Das, M.I. Khan, S.K. Behera, S. Il Yun, S.K. Tripathy, A. Mishra, Facile bio-synthesis of gold nanoparticles by using extract of Hibiscus sabdariffa and evaluation of its cytotoxicity against U87 glioblastoma cells under hyperglycemic condition, Biochem. Eng. J. 105 (2016) 264–272,http://dx.doi.org/ 10.1016/j.bej.2015.09.021.

Mohanpuria, P.; Rana, N.K.; Yadav, S.K. Biosynthesis of nanoparticles: technological concepts and future applications. *J. Nanoparticle Res*., 2008, 10, 507–517.

Mukherjee, P.; Ahmad, A.; Mandal, D.; Senapati, S.; Sainkar, S.R.; Khan, M.I.; Parishcha, R.; Ajaykumar, P.V.; Alam, M.; Kumar, R.; Sastry, M. Fungus-mediated synthesis of silver nanoparticles and their immobilization in the mycelial matrix: a novel biological approach to nanoparticle synthesis. *Nano Lett*.,2001, 1(10), 515–519. [https ://doi.org/10.1021/nl015 5274

Nadaroglu, H.;Onem, H.;Gungor, A.A. Green synthesis of Ce2O3 NPs and determination of its antioxidant activity. *IetNanobiot.*,2017, 11(4), 411-419. [https://doi:10.1049/iet-nbt.2016.0138]

Nam, J.M.; Thaxton, C.S.;Mirkin, C.A.Nanoparticle-based bio-bar codes for the ultrasensitive detection of proteins. *Science*, 2003, 301(5641), 1884-1886.

Narayanan, K.B.; Sakthivel, N. Coriander leaf mediated biosynthesis of gold nanoparticles. *Mat. Let.*2008, 62(30):4588-4590.

Pantidos, N.; Horsfall, L.E.Biological Synthesis of Metallic Nanoparticles by Bacteria, Fungi and Plants. *J.NanomedNanotechnol.*, 2014, 5: 233. [https ://doi: 10.4172/2157-7439.1000233]

Parashar, U. K.; Saxena, P.S. Bioinspired synthesis of silver nanoparticles. *J.Nanomater.*2009, 4,159–66.

Park, S.; Sung, H.K.; Kim, Y. Green Synthesis of Metal Nanoparticles Using Sprout Plants: Pros and Cons.*J. Nanosci. Nanotechnol*, 2016, 16 (5), 4444-4449. [https://doi:10.1166/jnn.2016.10970]

Patel, V.; Berthold, D.;Puranik, P.;Gantar, M. Screening of cyanobacteria and microalgae for their ability to synthesize silver nanoparticles with antibacterial activity. *Biotechnol Reports*, 2015, 5, 112–9. [https ://doi. org/10.1016/j.btre.2014.12.001]

Pelgrift, R.Y.; Friedman, A.J. Nanotechnology as a therapeutic tool to combat microbial resistance. *Adv. Drug.Deliv. Rev*.,2013, 65,1803–15.

Philip D, Rapid green synthesis of spherical gold nanoparticles using Mangifera indica leaf, Spectrochim. Acta - Part A: Mol. Biomol. Spectrosc. 77 (2010) 807–810, http://dx.doi.org/10.1016/j.saa.2010.08.008.

Ravindra, B.K.;Rajasab, A.H. A comparative study on biosynthesis of silver nanoparticles using four different fungal species. *Int. J. Pharm. Pharm. Sci*.,2014, 6(1),372–376.

Roy, K.; Mao, H.Q.; Huang, S.K.; Leong, K.W. Oral gene delivery with chitosan--DNA nanoparticles generates immunologic protection in a murine model of peanut allergy. *Nat. Med.*1999, 5(4), 387-91.

Sachlos, E.;Gotora, D.;Czernuszka, J.T. Collagen Scaffolds Reinforced with Biomimetic Composite Nano-Sized Carbonate-Substituted Hydroxyapatite Crystals and Shaped by Rapid Prototyping to Contain Internal Microchannels.*Tissue Eng.*,2006, 12: 2479.[https://doi.org/10.1089/ten]

Sanghi, R.; Verma, P. Biomimetic synthesis and characterisation of protein capped silver nanoparticles. *Bioresour. Technol.* 2009, 100, 501–504. [https :// doi.org/10.1016/j.biortech.2008.05.048]

Sava G, Bergamo A. Ruthenium drugs for cancer chemotherapy: An ongoing challenge to treat solid tumours. Cancer Drug Discovery and Development. 2009;1:57-66. DOI: 10.1007/978-1-60327-459-3_8

Shaligram, N.S.; Bule, M.; Bhambure, R.; Singhal, R.S.; Singh, S.K.; Szakacs, G.; Pandey, A. Biosynthesis of silver nano-particles using aqueous extract from the compactin producing fungal strain. *Process.Biochem*.,2009, 44, 939–43. [https ://doi.org/10.1016/j. procb io.2009.04.009]

Shankar, S.S.; Rai, A.; Ahmad, A.; Sastry, M. Rapid synthesis of Au, Ag, and bimetallic Au core-Ag shell nanoparticles using Neem (Azadirachtaindica) leaf broth. *J. Colloid Interface Sci.*, 2004, 275: 496-502.

Shivaji, S.; Madhu, S.; Singh, S. Extracellular synthesis of antibacterial silver nanoparticles using psychrophilic bacteria. *Process Biochem.*, 2011, 46(9),1800–1807. [https ://doi.org/10.1016/j.procb io.2011.06.008]

Siddiqi, K.S.;Husen, A. Fabrication of Metal and Metal Oxide Nanoparticles by Algae and their Toxic Effects. *Nanoscale Res. Let.*,2016, 11(1), 363. [https://doi:10.1186/s11671-016-1580-9]

Singh, J.; Singh, N.; Rathi, A.; Kukkar, D.; Rawat, M. Facile approach to synthesize and characterization of silver nanoparticles by using mulberry leaves extract in aqueous

medium and its application in antimicrobial activity. *J.Nanostruct*. 2017, 7:134–40. [https ://doi.org/10.22052 /jns.2017.02.007]

Singh, J.; Mehta, A.; Rawat, M.;Basu, S. Green synthesis of silver nanoparticles using sun dried tulsi leaves and its catalytic application for 4-nitrophenol reduction. *J. Environ. Chem. Eng.*,2018, 6,1468–74. [https :// doi.org/10.1016/j.jece.2018.01.054]

Singh, P.; Jain, S. Biosynthesis of Nanomaterials: Growth and Properties. *Rev. Advanced Sci. Eng.*,2014, 3, 1–8.

Singh SK, Pandey DS. Multifaceted half-sandwich arene-ruthenium complexes: Interactions with biomolecules, photoactivation, and multinuclearity approach. RSC Advances. 2014;4:1819-1840. DOI: 10.1039/C3RA44131HSuganya *et al.*, (2016)

Sunkar, S.;Nachiyar, C.V. Biogenesis of antibacterial silver nanoparticles using the endophytic bacterium *Bacillus cereus* isolated from *Garcinia xanthochymus*. *Asian. Pac. J. Trop. Biomed.*,2012, 2(12), 953-959. https ://doi. org/10.1016/S2221 -1691(13)60006-4

Thakkar, K.N.; Mhatre, S.S.; Parikh, R.Y. Biological synthesis of metallic nanoparticles. *Nanomedicine*,2016, 6, 257-262.

Tiple A., Badwaik V, Chaudhary R, Singh N A review on Nanotoxicology: Aquatic environment and biological system *Materials Today: Proceedings* , 2020 29(4), 1246-1250 *https://doi.org/10.1016/j.matpr.2020.05.755*

Veerasamy, R.; Xin, T.Z.; Gunasagaran, S.; Xiang, T.F.W.; Yang, E.F.C.; Jeyakumar, N.; Dhanaraj, S.A. Biosynthesis of silver nano- particles using mangosteen leaf extract and evaluation of their antimicrobial activities. *J. Saudi. Chem. Soc.*, 2011, 15(2), 113-120. [https ://doi.org/10.1016/j. jscs.2010.06.004]

Vigneshwaran, N.; Ashtaputre, N.M.; Varadarajan, P.V.; Nachane, R.P.; Paralikar, K.M.; Balasubramanya, R.H. Biological synthesis of silver nanoparticles using the fungus Aspergillus flavus. *Mater Lett*.,2007, 61,1413–1418. [https ://doi.org/10.1016/j.matle t.2006.07.042]

Yasmin, K. Ramesh, S. Rajeshkumar, Optimization and stabilization of gold nanoparticles by using herbal plant extract with microwave heating, Nano Converg. 1(2014) 12, http://dx.doi.org/10.1186/s40580-014-0012-8.

ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS OF HONEY SAMPLE OF *APIS DORSETA* FROM DIFFERENT AREAS OF TUMAKURU TALUK, KARNATAKA

Parimala B.

Department of Zoology,

University College of Science, Tumkur University, Tumakuru, Karnataka 572 103

Corresponding author E-mail: parimala.bb@gmail.com

Abstract:

Honey contains eighty different substances with importance to the human health and has also found its way into traditions, rituals and customs of various cultures and religion across the world. Honey is delicate, sweet, viscous substance collected, elaborated and stored in combs of honeybees. Honey has been used in medicine not only as a valuable item in the diet but as a remedy and a means of healing. Honey samples exhibited variations not only with respect to physico-chemical parameters like colour, surface tension, viscosity, optical density, pH, laevulose, dextrose, sucrose, minerals, amino acids, vitamins but also in its flavour, aroma, its ani-oxidant properties and volatile oils. The present study reveals the physico-chemical parameters of honey of different areas of Tumakuru Taluk. Honey samples from various regions indicate the diverse nature of flora, climatic, temperate and edaphic factors. All honey samples exhibited acceptable standard levels of all the parameters as prescribed by BIS. The study also revealed that the sample obtained from the forest region was preferable over the honey from the other regions with respect to aroma and flavour. The study suggests that the wide diversity of honey can be restored, provided the nature is intact without any intrusion of anthropogenic factors.

Keywords: Honey, Physico-chemical parameters, Rural, Urban, Forest, Tumakuru,

Introduction:

Honeybees and flowers are classical examples of mutualism and co-evolution. Honeybees are reliant on floral wealth like nectar and pollen. The word honey itself indicates that it is having pleasant taste and it also employed for many therapeutic activities from olden days. It is a delectable sweet product, which essentially consists of simple sugars, predominantly laevulose and dextrose (Kalpana *et al.*, 1996). Major chemical components of honey include

sugars which represent the largest portion about 82% of honey composition (Hack-Gil *et al.*, 1988). Honey as substance produced by Honey bees by sucking the secretions of plants or from honeydew by regurgitation. Naturally Honey bees produce a hundred grams of honey visiting nearly a million flowers to produce it. The amount of honey produced from the floral nectaries depends on the total quantity of nectar secreted and the sugar concentration of the nectar (Seema and Sudha, 2003). The composition of honey depends on the type of flowers visited by bees, climatic conditions in which the plants grow and maturation (Abou-Tarboush *et al.*, 1993; Ankalm, 1998). Honey has a high calorific value, 1kg of honey containing 3150-3350 calories. Nectar consists of ions, organic acids, terpenes, alkaloids, flavonoids, carotenoids, xanthophylls, glycosides, vitamins, volatile oils, pinocembrin, galagin, polyphenols, tocopherols, lycopene and amino acids which are obviously found in honey. Because of this unique, complex and distinctive quality, honey finds place in antiseptic, laxative, antibiotic, pacifier, anti-oxidant and ingredient of variety of pharmaceutical, bakery, cosmetics, confectionary, and tobacco industry. In India we can observe majorly *Apis dorsata, Apis indica, Apis cerena, Apis florea* species. The physico- chemical analysis of honey is important to the honey industry, as these factors are intimately related to storage quality, granulation, texture, flavor, and the nutritional and medicinal qualities of honey.

No information is available on the colour, physico-chemical parameters and aroma of A.dorceta honey of Tumakuru area. The primary aim of the current study is to provide comprehensive information on the colour, physico-chemical parameters aroma and flavor of honey of A.dorseta honey of different areas of Tumakuru Taluk.

Materials and Methods:

Study area:

Tumkur Taluk (Fig. 1) occupies a total area of 48.60 sq. km. The temperature varied from 13^{o} C to 41^{o} C and the humidity ranges from 32.6% to 86.45%. Agriculture and tourism are main sources of economy to Taluk in addition to beekeeping with colonies *A.dorseta* and *A.cerana* are additional source of economy.

Preparation of honey samples:

Honey samples of *A.dorseta* are collected with the help of hunters from different areas Rural, Forest and Urban [Plate 1]. The samples were collected in sterilized polythene bottles from the place of honey extraction. All three raw honey samples before analysis were stored in sterilized glass bottles. The raw honey samples were filtered through single thickness fine cloth

to remove suspended particles like dirt, beeswax and other impurities. Later it was stored in airtight containers at room temperature.

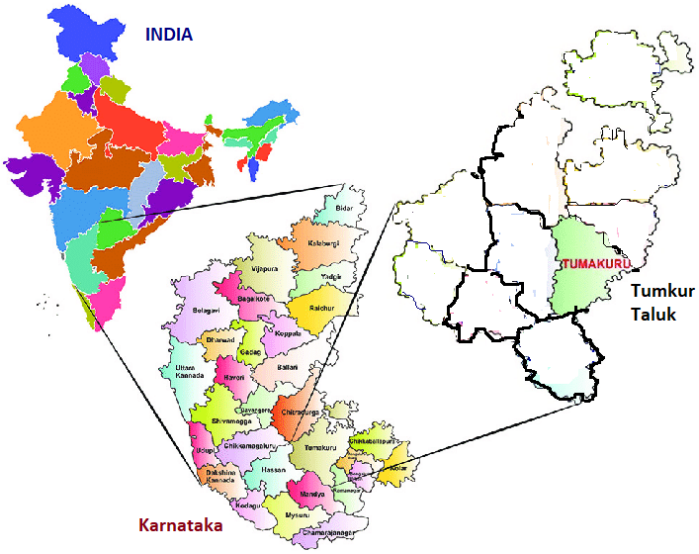


Figure 1: Map showing the study area

Determination of refractive index of honey:

It was measured with the help of Abbe's refractometer (Shripad and Rangaswamy, 2001).

Detection of optical density of honey:

It was determined by colorimeter (Balasubramanyam and Chandrasekhara, 2003).

Measurement of viscosity of honey:

It was measured by Oswald's viscometer (Balasubramanyam and Chandrasekhara, 2003).

Ash:

The ash content was determined through ignition of honey samples in a muffle furnace at 550oC to a constant weight. Major sugars and total reducing sugar were estimated by the standard methods described by Wood *et al.* (1975) and Ruck (1963).

Results and Discussion:

The ANOVA of refractive index of honey samples from different areas was not significant at 1% levels. Similar results were reported by Vit *et al.* (1994) in Venezuelan honeys. Lesser refractive index indicates higher moisture content and higher refractive index means lower moisture content of nectar and honey [Table 1]. The ANOVA of optical density of the honey samples was not significant at 1% levels [Table 1]. The optical densities of all honey samples are laevorotatory due to high amount of fructose. Fresh and pale honeys have less O.D compared to dark honey samples. Colour variation of honey is entirely due to presence of TSS,

although, the colour may fluctuate depending on the storage conditions. Usually light floral honeys are mild in flavor than the darker honey (Wakhle, 1997). The flavor and aroma judgments are personal, individual preferences may differ considerably and the ANOVA of viscosity of honey samples from was significant at 1% levels [Table 1].

Plate 1: Honey Samples.

Table 1: Different parameters of honey samples

Sr. No.	Sample	Refractive Index	Specific Gravity	Optical Density	Viscosity	Ash %
1	Rural	1.58	1.78	0.78	78.94	0.12
2	Forest	1.61	1.81	0.81	86.28	0.15
3	Urban	1.48	1.52	0.52	72.36	0.09

Table 2: Different parameters of honey samples

Sr. No.	Sample Code	Sugar composition (%)				Granulation indices			
		G %	F %	S %	TRS	F/G	F-G	G/W	(G-W/F)
1	Rural	36.04	38.31	0.35	73.25	1.04	1.67	1.84	0.43
2	Forest	34.22	32.78	1.04	71	1.06	2.87	1.3	0.23
3	Urban	36.04	35.25	0.47	73.21	1.02	1.11	1.41	0.32

The viscosity depends on a large variety of substances and varies with its composition and particularly with its water content. It is an important parameter during honey processing because it reduces honey flow during extraction, pumping, settling, filtration, mixing and bottling. The viscosity of a honey sample is a function of the composition of its sugars, water and colloid content. If the concentration of water is increased, honey

becomes less viscous. Viscosity is measure of the resistance of fluid to flow caused by internal friction, and also depends on the nature of nectar. Viscosity of honey samples decrease with the increase in temperature (Sharma, 1998). Specific gravity of honey depends on the water content of the honey and is greater than water. In present study the specific gravity ranged between 1.52 - 1.78 (Table 1), which are similar to the values observed by various workers from India (Singh, 1983; Manjunath, 1999; Tiwari *et al.*, 2010). The ash content in honey is generally small and depends on nectar composition of predominant plants in their formation (Al-Khalifa and Al-Arify, 1999). The ash content in the honey samples varied between 0.09 - 0.18 % (Table 1), which is in the acceptable range. The ash content is associated with botanical and geographical origins of honey samples.

Glucose, fructose and sucrose are the major constituents of honey. The glucose, fructose and sucrose contents ranged from 3304% to 36.04%, 32.7% to 38.3% and 0.35% to 1.04% respectively (Table 2). The total reducing sugar (TRS) content was varied between71% to 73.6% (Khatija and Ramanujan, 1993). The large difference between fructose and glucose percentage in honey, indicates lower granulation tendency. Analyzing the relationship between granulation and indices type suggests that the fructose to glucose ratio may not be an effective gauge of granulation tendency. While glucose percentage is a useful indicator of honey granulation, the glucose to water ratio appears to be one of the most effective indicators predicting granulation in honey. The glucose to water ratio may be used both to predict and control granulation tendency. Glucose to water ratios of 1.7 or less were considered non-granulating, while ratios of 2.1 or more predicted rapid granulation (Jamieson, 1954; White, 1975; White, 1962). In present investigation the glucose to water ratio varied from 1.3 to 1.84 and showed moderate granulation properties (Table 2). In our study the glucose- water to fructose ratio ranged between 0.23 and 0.47, which showed relatively low granulation tendency. The honey fructose to glucose ratio reaching 1.14 indicates a tendency to granulate more rapidly than the honey with a ratio significantly below 1.14 (White, 1975; White, 1962; K.oudounis, 1962). It is generally believed that the higher glucose content has the greater tendency toward granulation. Therefore, the granulation process should be avoided through proper storage index practices that maintain optimal storage temperature.

Conclusions:

The physico-chemical parameters selected in the present study includes refractive index, optical density viscosity, Sugar composition and Granulation indices of the honey samples. All

the test factors exhibited remarkable quantitative variations in three different areas of Tumakuru Taluk viz., rural, forest and urban honey samples. Refractive index and optical density was extremely low in the samples while the viscosity of honey was much higher in forest sample when compared to rural and urban samples. The quality of forest honey is more compare to urban areas, so we can make sure that we can easily increase the quality of honey in urban area by planting more flowering plants which blooms bright coloured like Sunflower, Coneflowers, Goldenrod. This study would be helpful to understand local honey properties and very important towards the commercialization of regional honey.

References:

Abou-Tarboush, H., Al-Kahtani, H., and El-Sarrage, M., 1993, Floral type identification and quality evaluation of some honey types. Food Chemistry, 46, 13-17.

Al-Khalifa, A. S., and Al-Arify, I. A., 1999, Physicochemical characteristics and pollen spectrum of some Saudi honeys. Food Chemistry, 67, 21-25.

Anklam, E., 1998, A review of the analytical methods to determine the geographical and botanical origin of honey. Food Chemistry, 63(4), 549-562.

Balasubramanyam, M.V and Chandrasekhara Reddy, C. 2003. Physical characteristics of multifloral wild and apiary honey from plains, hills and Western Ghats of Karnataka. Indian Bee J. 65(3&4): 113-117.

Hack-Gil, C. Myung-Kyoo, H., and Jae-Gil, K., 1988, The Chemical composition of Korean Honey. Korean Journal of Food Science Technology, 20, 631-636.

Jamieson, C. A., 1954, Some factors influencing the crystallization of honey. Rep. La St. Apiar, I 64/58 (1954), pp. 64-37.

Kalpana, T. P. and Ramanajum, C.G.K. 1996. Sugar cane honeys its significance. Curr. Sci. 70(4): 261-262.

Khatija, F. and Ramanujan, C. G. K., 1993, Pollen and chemical characterization of Apis cerana and A.florea honeys from Hyderabad urban complex. Journal of Palynology, 29, 59-67.

Koudounis, M. I., 1962, The crystallization of honey. Ph. D. Thesis. Athens, University of Athens, Ministry of Agriculture, pp. 88.

Manjunath, M.N., 1999, Carbohydrates of Indian honey. Ph. D Thesis In: Food Science, University of Mysore, India.

Ruck, J. A., 1963, Chemical methods for the analysis of fruits and vegetables products. Canada.

Seema Singh Thakur and Sudha Kanaujia 2003. Influence of day hours, temperature and relative humidity on nectar-sugar secretion pattern and Honey bee visit in neem, Azadirachtaindica (Meliaceae). Indian Bee J. 65(3-4): 100- 104.

Sharma, A., 1998. Physico-chemical analysis of some honeys from North-west Himalayas, Ph.D., Thesis, Himachal Pradesh University, Shimla, India, pp 84-99.

Shripad N. Agashe and Rangaswamy, B.E.2001. Chemical characterization of Apiscerana F and Apisdorsata F. honey from Dakshina Kannada, Karnataka (India), Indian Bee J. 63(3&4): 15-20.

Singh, Y., 1983, Beekeeping in Uttar Pradesh. A review**.** Indian Bee Journal, 45(2-3): 84-91.

Tiwari, P., Tiwari, J. K., and Radha Ballabha, 2010, Studies on Sources of Bee-forage for Rock Bee (Apis dorsata F.) from Garhwal Himalaya, India: A Melissopalynologaical Approach, Nature and Science, 8(6), 5-15.

Vit, P., Martorelli, I.G., de and Lopez, P.S.1994. Classification of commercial Venezuelan honeys`. Archivos – Latinoamericanos de Nutrition **1**: 47 – 56.

Wakhle, D.M. 1997. Beekeeping Technology - Production, Characteristics and Uses of honey and other products. In Perspectives in Indian Apiculture (Ed. R.C. Mishra, Agro- Botanica, Bikaner) p 134-139.

White, J. W., 1975, Physical characteristics of honey. In: Crane, E. (ed.) "Honey A Comprehensive Survey", Heinemann. London, U. K., pp. 608.

White, J. W., Riethot, M. L., Subers, M. H. and Kushir, I., 1962, Composition of American honeys. Technical Bulletin, U .S.D.A. No. 1261, pp. 124.

Wood, P. J., Siddiqui, I. R., Weisz, J., 1975, Determination of glucose and fructose in honey. Journal of Apicultural Research, 14(1), 41-45.

MECHANISM OF SURVIVING IN EXTREMES

Vinda Manjramkar

Department of Zoology

B. N. Bandodkar College of Science (Autonomous), Thane

Corresponding author E-mail: vindamanjramkar@yahoo.com

Some living organisms enter in low or no physical and physiological activity in order to survive the extreme climatic condition. It is genetically coded when to enter such phase depending upon the signal from environment and the body's biological rhythm**.** Viruses, bacteria, protozoan also use this method for the survival. Viruses remain metabolically inactive for many years, bordering the death -life thin line,viruses such as poxviruses and picornaviruses after entering the host can become latent for long periods of time or even indefinitely until they are externally activated. Every organism has to get fair chance of survival (planet belongs to all), as it is survival of fittest.we intake antibiotic, vaccinesto renderthem unfit for survival, but they have found theway of survival undergoing mutation,having small amount of genome makes it quite easily possible.In higher animals, when the environment becomes too hostile for an animal, they have to find a way to cope. Some animals migrate out of the area, while others enter an inactive state, which they stay in until conditions suit them better. If this inactive state lasts for a long time during the winter, it is called hibernation, but if it is in a hot climate, it is called aestivation

Mechanism in virus and bacteria

Virus latency (or viral latency) is the ability of a pathogenic virus to lay dormant (latent) within a cell, denoted as the lysogenic part of the viral life cycle (Villarreal, 2005). The herpesviruses that infect humans characteristically establish a latent infection that may be reactivated later. The consequences of reactivation range from asymptomatic shedding to severe disseminated infection.Latent herpes simplex virus is known to reside in neurons, Epstein-Barr virus is also known to persist in a non-replicating state as extrachromosomal DNA in B lymphocytes (the immune cells of system) to cause "immortalization" of the infected cell; persistence of the viral genome in epithelial cells may also result in malignant transformation, such as nasopharyngeal carcinoma (Jordan *et al.,* 1984). More serious ramifications of a latent infection could be the possibility of transforming the cell andthereby forcing the cell into uncontrolled cell division. This is a result of the random insertion of the viral genome into the host's own gene and expression of host cellular growth factors for the benefit of the virus.

Thelatency in reservoir of HIV may be the inability of antiretroviral treatment to cure HIV infection (Finzi *et al.,* 1997; Chun and Fauci, 1999; Persaud *et al.,* 2000; Blankson *et al.,* 2002). Viruses show three types of latencies, Episomal latency, Proviral latency, maintaining latency. In the Episomal latency type, viral genes are stabilized, floating in the cytoplasm or nucleus as distinct objects. In the proviral; provirus is a virus genome that is integrated into the DNA of a host cell. The virus gets advantages of proviral latencyas (automatic) host cell division results in replication of the virus's genes and the fact that it is nearly impossible to remove an integrated provirus from an infected cell without killing the cell (Marcello, 2006). Maintaining latency; both proviral and Episomal latency may require maintenance for continued infection and fidelity of viral genes.Thus, viruses have survived from ancient times, many of them have been endogenous inhuman, we have 4-5 percent genome of some viruses included in as human genome.

Many bacteria can survive in the adverse conditions such as extreme temperatures, desiccation, and antibiotics by forming endospores, cysts, or states of reduced metabolic activity lacking specialized cellular structures (Sussman, and Douthit, 1973). Cytoplasmic fluidity and dynamics in bacterial cell dramatically change as cells shift between metabolically active and dormant states in response to fluctuating environment. During dormancy, when such metabolic activities are put on hold, the cytoplasm behaves like a solid glass, 'freezing' subcellular structures in place and perhaps protecting them, while allowing small molecules like metabolites to move freely through the cell, which may be helpful in cells transitioning out of dormancy (Parry, 2014). The species of Gram-positive genera Bacillus, Clostridium, Desulfotomaculum, Sporolactobacillus, and Sarcina form endospores on confronting the adverse environmental conditions, like lack of water or depletion of essential nutrients, and so forth.we are still unable to control tuberculosis as tuberculosis bacillus can remain as spore for hundreds of years and infect the host.Besides endospores, some bacteria develop exospores (e.g., Methylosinus trichosporium) or undergo encystment to form cysts (e.g., the species of genera Methylocystis and Azotobacter). Many species of Azotobacter can withstand drying of the soil for significantly long times without undergoing any structural or physiological change (world encylopedia).

Mecanism in higher animals

Dormancy

Dormancy is the stopping of physical activity by organism also minimizes metabolic activity thereby help an organism to conserve energy. Dormancy is said to be closely associated with environmental conditions. In ‘Predictive’ dormancy the animal enters dormant stage as it

receives presignals from environment stating the arrival of adverse condition, like the decrease in photoperiod, temperature, scarcity of water. Whereas in the 'Consequential'dormancy organisms enter a dormant phase after adverse conditions have arisen, this is a sudden phase where organism unprepared, it can occur due to unpredictable climate changes, this can cause high rate of mortality, but at times it can be beneficial as organism can use maximum resources for survival.Dormancy has become an essential part of the life cycle, allowing an organism to pass through critical environmental stages in its life cycle with a minimal impact on the organism itself. There are different types of dormancytorpor, hibernation, brumation, aestivation and diapause

Torpor

Torpor is a state of lowered body temperature and metabolic activity assumed by many animals in response to adverse environmental conditions, especially cold and heat. The torpid state may last overnight, as in temperate-zone hummingbirds and some insects and reptiles; or it may last for months, in the case of true hibernation

Birds typically do not hibernate, instead utilize torpor. An exceptional bird known as the Poorwill does hibernate (Jaeger, 1948). In 13 bird families known to contain heterothermic species, the common poorwill (Phalaenoptilus nuttallii) is the only species that ostensibly hibernates. Poorwills selected winter roosts that were open to the south or southwest, facilitating passive solar warming in the late afternoon. The findings showed that during winter poorwills exhibit physiological patterns and active rewarming similar to hibernating mammals (Christopher *et al.*, 2019). Many experts believe that the processes of daily torpor and hibernation form a continuum. These are nocturnal members of the nightjar family are the only bird species known to go into a torpor, a similar state to hibernation, during which the animals can bring their body temperature down to 41 degrees.

On nearing of the sun set, hummingbirds increase their feeding in order to prepare themselves for their nighttime sleep. They go into a deep sleep similar to a bear going into hibernation for the winter, but they do it every night this called as daily torpor, torpor (pronounced TOR-per) and it is a state where the bird slows down all of its body functions for the night. The heart rate, body temperature, decreases, they hand upside down. The duration of their torpor varies from 5 to 10 hours. The researchers noted that the longer the birds remained in torpor, the lower their loss of body mass. They fed on stored fat to keep just warm enough to stay alive. This ability makes a hummingbird a "heterotherm," meaning they can switch between being both warm-blooded and cold-blooded (Bob Yirka, 2020) Raccoons and raccoon dogs, at least in parts of their range, also enter torpor for several weeks. Short-term torpor of several days

or even daily torpor is much more widespread also among larger mammals – both American and European badgers enter daily or short-term torpors, with body temperatures of about 28 °C. Daily or short-term torpor, in general, reduces body temperatures to 10–30 °C; metabolic rates are reduced to values of about 30%. Most mammal species entering daily torpor are small and nocturnal such as small marsupials (dasyurids, petaurids, and didelphis), mouse lemurs, hedgehogs, tenrecs, shrews, or bat (Encyclopedia of Ecology, 2008). The extended torpor is hibernation.

Hibernation

Hibernating mammals are good models for investigating the relationship between physiology, behavior, and environment, as hibernation patterns are important determinants of survival (Turbill *et al.,* 2011). Hibernation may be predictive or consequential.This is an energy-saving mode and is characterized by many physiological changes, mainly decreased body temperature, decreased heart rate (by as much as 95 percent), and lower metabolic rate.Animals that hibernate include bats, ground squirrels, other rodents, mouse, the European Hedgehog and other insectivores, monotremes, marsupials and lemurs. The animals turn off its thermostat, the most famous hibernator is bear the temperate species of genus Ursus, experiments conducted on brown bears showed that entry in the den for hibernation was controlled by climate warming climate could result in later den entry.There studies suggested that Scandinavian brown bears terminated their hibernation due to physiological cues (Singh *et al.,* 2016). Although many studies have shown that den entry and exit are related to food availability, but climate change also appears to be an important factor affecting the timing of the life events of the brown bear. In present scenario of climate change there is reduction in hibernation time of black bears, lead to have implications for human–bear conflicts (Pigeon *et al.,* 2016; Krofel *et al.,* 2017). In the colder, northern parts of Alaska, bears hibernate about 7 months of the year. Bears in the warmer, coastal regions of this area hibernate for 2-5 months. Bears have developed unique adaptive strategies in order to survive for so long without food and water (Stenvinkel *et al.,* 2013). They utilse the body fat, especially the brown fat for the maintenance of the body physiology. They also almost donot defecate or urinate, bears have unique ability to recycle urea (aminoacids are recycled again by the body to build up proteins) during hibernation, so also they form anal plug called ‘tappen’or‘Rectal Plug’ to stop defecation and prevent entry of insects during hibernation, however is found that Bears will go through a lot of posture changes where they wake periodically to shift around.It is thought this helps prevent pressure sores from developing. Bears also shift positions to better conserve heat. Bears body temperature only drop

3-5ºC compared to other animals, bears body temperatures drop 32ºC or more. During hibernation a Black bear's heart can drop from 40-50 to 8 beats per minute.The hibernating animals have ability to heal wounds which is a survival advantage in hibernating species, decreased peripheral blood flow during hypothermia and immobilization may impede delivery of oxygen and nutrients to the wound site. Bears in zoos donot hibernate as food is available, though they will slow down and sleep more than usual. Ethically more zoos are allowing their bears hibernate during winterit helps the bears stay leaner and healthier.

Bears mate in the spring, but the fertilized eggs do not immediately begin developing into bear embryo. Instead, the fertilized eggs suspend development until the fall (Embryonic diapause). It is believed that sometime around the beginning of hibernation the eggs implant into the uterine wall. It's counter-intuitive – just as the mother bear stops eating and begins to slow down for hibernation, the eggs within her begin growing into embryos.The cub is born after just a few months of development in the mother's womb. The cubs eyes are closed and can do little movements attaching to the nipple. The tiny bear cubs are just a fraction of one percent the mother bear's weight (Alaska Fish & Wildlife News June 2007 Riley Woodford). Females of some bear species, including American black bears, will enter hibernation for the duration of their pregnancy. Nearly all pregnant Asiatic black bears hibernate as well. The mothers will greatly increase their body mass before hibernating and gestation will occur while they are dormant. The offspring are born either during or shortly after the period of hibernation. The health and weight of the offspring is a direct reflection of how much weight the mother could amass before hibernating.

Marmots hibernate for up to eight months.Four months they are awake having breeding, raising pupsand preparing for the next hibernation. During hibernation they take only 2-3 breaths a minute and their heartbeat slows down from their normal 120 beats to 3-4 beats a minute.

Fat-Tailed Dwarf Lemurs (the noctural animals and highly endangered species) of Madagascarthe coldest time of the year, Lemurs finds a tree and settle there for about seven months until the rains return in November and food is available again, they utilize the fat.

Hedgehogs are some of the deepest hibernators, Hedgehogs are immobile during hibernation they are very vulnerable to climate and disturbance hence, the need for protective hibernacula.

Dormice (*Glis glis*) family Gliridae, French word "dormir," which means to sleep. They can hibernate for more than 11 months at a time, more dormice die in hibernation than at any other time. Dormice that live in temperate climates go through long periods of hibernation lasting six months or more. They make their nests along the forest floor, hidden by logs and piles

of leaves. While analyzing rodent fossils, scientists (funded by the Swiss National Science Foundation) have come up with a novel hypothesis: hibernation was a survival strategy 34 million years ago. Some rodent fossils suggest that hibernation was an established strategy 2.6 million years ago—their incisors show seasonal interruptions in growth. It is thought that this ability to hibernate emerged and spread in response to the difficult survival conditions at the time, which corresponds to the beginning of the Quaternary ice age—the current geological period (Swiss National Science Foundation, 2021). Ancestors of Dormice may have hibernated as early as 34 million years ago.

The Alaskan (Arctic Circle) ground squirrel curls into furry little balls within burrows deep underground, as if dead. The squirrel is as cold as ice — literally. Its body temperature is -2° Celsius (28° Fahrenheit). Its heart beats only once every 15 seconds. Its breathing stops for minutes at a time (Bethany Brookshiresns@sciencenews.org). "These small hibernators can survive having their brains essentially turned off at these low temperatures,"

In hibernating animals male arouse first, they are shown to begin with process of spermatogenesis, making the territory, female arouse latter.

Brumation

In the wild, reptiles are presented with both internal and external cues that it is time to brumate. Herpetologists have classified these cues into two main categories. The first are endogenous cues, which originate within the animal. Theories regarding endogenous cues suggest that some reptiles (but certainly not all) undergo hormonal changes as well as shifts in neurotransmitter levels and amino acid concentrations. These factors are directly affected by circadian rhythms and the environment, making these biological cues little more than a secondary function of natural climatic changes. It is still unknown fact whether internal changes occur spontaneously and trigger brumation or if the animal begins to brumate and then these physiological changes occur (Reptilian Brumation by Jonathan Rheins)

Winter dormancy in reptiles, which is also called brumation, is akin to hibernation in mammals. Instead of experiencing long, sustained periods of inactivity, brumating reptiles occasionally to drink water; however, they may go without food for several months.in cooler winters we in tropical areas also do not find wall lizard (geckos)movements at night.Reptiles can tolerate colder temperatures much better than they can tolerate higher ones. For this reason, during hot weather they must seek refuge underground or in cool, shady places, where they remain physiologically active. Desert reptiles, in particular, exhibit such temperature responses daily. Brumation is the appropriate term used for the period of dormancy that most commonly

occurs in reptiles in the colder months. During brumation; many animals will stop eating, bury them and may or may not intermittently wake to drink. This process is commonly practiced by temperate species (most box turtles species) and is necessary for reproductive health (Boyer and Donal, 2006), brumation typically occurs between the months of October to April in north hemisphere. Brumation behaviour is induced by a reduction in environmental temperatures (by 5-15°C dependingon species) and daylight hours.During brumation, snakes migrate into warmer places such as dens, burrows made by other animals where they will bury themselves or in tree stumps, caves, and deep caverns in the wild. Survival is their main goal during brumation. In the cities and suburbs, snakes crawl into spaces like basements, boiler rooms, garages, woodpiles, open pipes, barns, sheds, storage spaces, or even car engines to keep warm.sub-tropical animals, as well as those found near the equator, often do not undergo what herpetoculturists call a "true brumation."Reproductive Connotations cooler temperatures trigger the production of sperm in males, and prepares females for ovulation in spring, however, if the choice of hibernaculum is poor, they donot emerge in spring, reptile like the hibernators brumate to heal the injury.The length of time a reptile brumate is extremely variable (Reptilian Brumation By Jonathan Rhein).

Aestivation

The phenomenon of laying inactivedue to the summer heat is aestivation. Invertebrate and vertebrate animals are known to enter this state to avoid damage from high temperatures and the risk of desiccation. Both terrestrial and aquatic animals undergo aestivation (Pinder etal1992),by creating burrows. The aestivator depends on burrow buffered soil micronutrients then the upper strata nutrients. Among invertebrates (e.g., earthworms and insects) aestivation usually involves an inactive stage with a water-resistant covering. For example, aestivating earthworms, form a mucus cocoon to resist desiccation, many insect pupae are remarkably resistant to water loss. Amongst vertebrates, fishes, amphibians, and reptiles enter a similar aestivation state. Fishes and amphibians often form a cocoon of dried mucus (e.g., African lungfishes), African and Asian clariid catfishes have long been reputed to survive habitat desiccation by remaining dormant under dry mud or sand, in the manner of the lungfish Protopterids. (Bruton, 1979) or shed epidermal layers (e.g., some desert frogs) to resist epidermal water loss; the cocoon covers the entire body surface except for the nostrils. Reptiles have a relatively water-impermeable epidermisas the skin is has scales, warts and do not need to form a cocoon to reduce evaporative water loss. Aestivating ectotherms typically have an intrinsic metabolic depression for energy conservation (Encyclopedia of Ecology, 2008). The fossil record suggests that aestivation may have evolved several hundred million years ago.

Diapause

Diapauseis an endocrine-mediated metabolic and developmental arrest induced by changes in abiotic cues that indicate the onset of adverse environmental conditions (Yevgeniya *et al.,* 2013). Some species undergo diapause as early embryos; while others enter diapause as pharate first instar larvae ("hatch-ready" larvae) within the eggshell.Diapause in the adult stage is characterized by a halt in reproduction. Adult diapause is especially common in the Coleoptera, but is also well seen among the Lepidoptera, Diptera, Hymenoptera, Hemiptera, Homopteran, Orthoptera and Neuropteran (Denlinger, 2000). Embryonic diapause is defined as the temporary suspension of development of the embryo and occurs in more than 130 mammalian species including the mouse and rat as well as a wide range of species of bears, seals, bats, and marsupials (Fenelon *et al.,* 2014). Embryonic diapause occurs at the blastocyst stage for variable lengths of time.

Hibernation, torpor, and sleep are integral to energy homeostasis.One function of sleep is to restore brain energy homeostasis, while the primary function of hibernation and torpor is to restore or protect somatic energy homeostasis (Drew and Jinka, 2021). Adenosine is unique amongst the putative mediators of torpor because it affects sleep.Adenosine is molecule in the body made from a sugar bound to a nitrogen-based material. It helps the body transport energy in molecules such as ATP. It also promotes sleep in people, In Hindu mythology Kumbhakarn brother of Ravan (a character) in Ramayana, well known to sleeps for 6 months (hypersomnia) probably adenosine must have played role in the sleeping nature of Kumbhakarn. To break sleep the coffee (Caffeine) like substance plays role to block adenosine receptors.Caffeine, an adenosine antagonist, is the most widely used mood-altering drug in the world. Caffeine is rapidly absorbed and distributed throughout the body with peak plasma concentrations typically reached 30–45 min after ingestion. The average half-life of caffeine is 4–6 h. Homeothermslike birds and mammals, are nearly to death in the hibernation, torpor, this is amazing phenomenon, human beings will face cardiac arrest if temperature of body drops to 32 degree or below (hypothermia).

References:

Blankson JN, Persaud D, Siliciano RF (2002). "The challenge of viral reservoirs in HIV-1 infection". Annu. Rev. Med. 53: 557–93. doi:10.1146/annurev.med.53.082901.104024. PMID 11818490.

Boyer, Thomas H. and Donal M. (2006). Turtles, Tortoises, and Terrapins in Reptile Medicine and Surgery. 2ndedition

Christopher P Woods 1, Zenon J Czenze 2 3, R Mark Brigham (2019) Jan; Oecologia . 189(1):47-53. doi: 10.1007/s00442-018-4306-0. Epub 2018 Nov 20.The avian "hibernation" enigma: thermoregulatory patterns and roost choice of the common poorwill

Chun TW, Fauci AS (September 1999). "Latent reservoirs of HIV: obstacles to the eradication of virus". Proc. Natl. Acad. Sci. U.S.A. 96 (20): 10958–61. Bibcode:1999PNAS...9610958C. doi:10.1073/pnas.96.20.10958. PMC 34225. PMID 10500107

David L.Denlinger, (2000) Cell and Molecular Response to Stress Volume 1 Pages 259-275 Chapter 18 - Molecular Regulation of Insect Diapause.

Fenelon, Banerjee, & Murphy, (2014) Int J Dev Biol.. 2014;58(2-4):163-74. doi: 0.1387/ijdb.140074bm. Embryonic diapause: development on hold.

Finzi D, Hermankova M, Pierson T, *et al.,* (November 1997). "Identification of a reservoir for HIV-1 in patients on highly active antiretroviral therapy". Science. 278 (5341): 1295–300. Bibcode:1997Sci...278.1295F. doi:10.1126/science.278.5341.1295. PMID 9360927

Ganslosser U. (2008) Thermoregulation in Animals, in Encyclopedia of Ecology,

Jaeger EC (1948) Does the poor-will “hibernate”? Condor 50:45–46.

Jordan MC, Jordan GW, Stevens JG, Miller G (June 1984). "Latent herpesviruses of humans". Annals of Internal Medicine. 100 (6): 866–880. doi:10.7326/0003-4819-100-6-866. PMID 6326635

Karine E. Pigeon, Gordon Stenhouse & Steeve D. Côté(2016) Drivers of hibernation: linking food and weather to denning behaviour of grizzly bears Behavioral Ecology and Sociobiology volume 70, pages1745–1754

Kelly L. Drew, Tulasi R. Jinka. (2021)Chapter first Online: 23 July springer linkThe Bioenergetic Network of Adenosine in Hibernation, Sleep, and Thermoregulation. pp 253-272

Krofel, M., M. Špacapan ,K. Jerina, (2017);. Winter sleep with room service: denning behaviour of brown bears with access to anthropogenic food journal of zoology, First published: 04 December 2016 https://doi.org/10.1111/jzo.12421

Marcello A. (2006) "Latency: the hidden HIV-1 challenge." Retrovirology. Jan 16;3(1):7

Michael N. Bruton (1979) The survival of habitat desiccation by air breathing clariid catfishes;Environmental Biology of Fishes volume 4, pages273–280

Parry, BR (2014). "The Bacterial Cytoplasm Has Glass-like Properties and Is Fluidized by Metabolic Activity". Cell. 156 (1–2): 183–194. Bibcode:2014 APS..MARJ16002P. doi:10.1016/j.cell.2013.11.028. PMC 3956598. PMID 24361104

Persaud D, Pierson T, Ruff C, *et al.,* (April 2000). "A stable latent reservoir for HIV-1 in resting CD4(+) T lymphocytes in infected children". J. Clin. Invest. 105 (7): 995–1003. doi:10.1172/JCI9006. PMC 377486. PMID 10749578.

Peter Stenvinke, Alkesh H.Jani,Richard J.Johnson(2013) Kidney Internationa lVolume 83, Issue 2, February, Pages 207-212 Hibernating bears (Ursidae): metabolic magicians of definite interest for the nephrologist

Riley Woodford (2007) June Alaska Fish & Wildlife News : Riley Woodford is a writer with the Division of Wildlife Conservation at the Alaska Department of Fish and Game. He is the editor of Alaska Fish and Wildlife News and the producer of the “Sounds Wild” radio program.

Singh N. J., A. Friebe, J. M. Arnemo, T. G. Laske, O. Fröbert, J. E. Swenson, and S. Blanc (2016); Frontiers Zool 13: 7.Published online 2016 Feb 11. doi: 10.1186/s12983-016-0140-6PMCID: PMC4750243PMID: 26870151Drivers of hibernation in the brown bear.

Stephen J. Divers BVetMed, DZooMed, DACZM, DipECZM (herp), FRCVS, Douglas R. Mader MS, DVM

Sussman, AS; Douthit, HA (1973). "Dormancy in microbial spores". Annual Review of Plant Physiology. 24: 311–352. doi:10.1146/annurev.pp.24.060173.001523

Swiss National Science Foundation (2021)APRIL 22, Dormice may have hibernated as early as 34 million years ago

Turbill C, Bieber C, Ruf T. .(2011)Hibernation is associated with increased survival and the evolution of slow life histories among mammals. ProCR Soc Biol Sci Ser B. 2011;278:3355–3363. doi: 10.1098/rspb.2011.0190. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Villarreal, Luis P. (2005). Viruses and the Evolution of Life. Washington

Yevgeniya Antonova-Koch, Mark R. Brown (2013) Handbook of Biologically Active Peptides (Second Edition).

Yirka Bob (2020) Hummingbird reduces its body temperature during nightly torpor September 9, Phys.org

BIRDS AS PEST BIOCONTROL AGENTS FROM WESTERN MAHARASHTRA, INDIA

T. M. Chougale

Department of Zoology,

Bhogawati Mahavidyalaya, Kurukali - 416 001 (MS) India

(Affiliated to Shivaji University, Kolhapur)

Corresponding author E-mail: chougaletm75@gmail.com

Abstract:

Birds act as potential biocontrol agents controlling populations of agricultural pests. Pests especially arthropod pests form crop fields are controlled by different species of birds at every stage of crop development and helps in minimizing crop losses caused by the insect pests. Insectivorous birds play an important role in controlling pest population to great extent. In all, 21 species of birds have been reported as predators of insect pests from the region. The bird species includes *Egretta, Bubulues, Venelus, Eudynamys, Athene, Apus, Halcylon, Amaurornis, Acridotheres, Upupa, Saxicola, Dicrurus, Motavcilla, Corvus* etc. feeding on *Helicoverpa armigera, Spodoptera litura, Achea janata, Castor semilooper, Hieroglyphus banian*, mosquitoes, white grubs, crickets, grasshoppers etc. The birds were found predating on above insects in the fields of Kolhapur, Satara, Sangli and Pune districts of Western Maharashtra.

Keywords: Birds, Biocontrol agents, Pest insects, Kolhapur district.

Introduction:

Birds act as potential biocontrol agents controlling populations of agricultural pests. Pests especially arthropod pests form crop fields are controlled by different species of birds at every stage of crop development. While deciding the strategy for prevention of crop losses the study of birds as biocontrol agent is useful in minimizing the crop losses caused by pest populations. About 2,100 species of birds have been recorded from India and 550 from Maharashtra. Several workers (George and Mitchell, 1948; Dowden *et al.,* 1953; Massey and Wygant, 1954; Stewart and Aldrich, 1954; Brunn, 1957; Knight, 1958; Sweetman, 1958; Gibb, 1960; Tinbergen, 1960; Black *et al.*, 1971; Coppel and Solan, 1971; Van Vreden and Abdul, 1986) made attempts to study biological pest control through birds. In the present paper the account of important species of birds contributing pest control in the field condition have been taken.

Materials and Method:

For this purpose different areas of Kolhapur, Satara, Sangli and Pune district were visited during November 2019 to November 2021 at 15 days interval. One man two hour search method (Sathe, 2006) was adapted for spot observations. Observations were made during 7 to 9 a.m. and 4 to 6 p.m. Photographs and Videos of birds while feeding were taken during the field studies. Identification of bird species and pest species has been done by consulting appropriate literature. The fields were also surveyed for the pest occurrence before observations for pest control by birds. Observations were also made on predacious behaviour of birds.

Results:

Results are recorded in table No.1. The results presented in Table 1 indicated that cattle egret (*Bubulcus ibis*), redwattled lapwing (*Vanellus indicus*), hoopoe (*Upupa epops*), ashy drongo (*Dicrurus leucophaeus*, *D. adsimilis*) birds were dominant over others in view of feeding potential. The birds like pied buschat (*Saxicola caprata*), white wagtail (*Motacilla alba*), crow pheasant (*Centropus sinensis*) were also potential predacious birds.

Plate 1 : Birds feeding on insect pests in crop fields

Table 1: List of birds and the insect pests on which they predates

Sr. No.	Bird	Name	Occurrence	Insect predated
1	Small egret	*Egretta intermedia*	Paddy and grassy fields	Soil insects, e.g. white grubs
2	Ashy drongo	*Dicrurus leucophaeus D. adsimilis*	Deciduous forest, farms	Grasshopper Small winged insects, *Hieroglyphus banian*, etc.
3	Pied buschat	*Saxicola caprata*	Farms, shrubby regions	Small winged insects, Spiders and mites
4	Grey shrike	*Lanius excubitor*	Farms, deciduous forests and dry lands	Insects and insect larvae, *Helicoverpa armigera*
5	Hoopoe	*Upupa epops*	Farms	Insect grubs and Pupae, White grub
6	White wagtail	*Motacilla alba*	Road side trees and paddy fields	Insects, spiders and mosquitoes, *Spodoptera litura*
7	Crow pheasant	*Centropus sinensis*	Grassy lands, Gardens, Shrubbery	Grass hoppers, caterpillars and other large insects.
8	Common mynah	*Acridotheres tristis*	Farms, garden and urban areas	Grass hoppers and other insects, e.g. *Achea janata*, Red locust.
9	Spotted owlet	*Athene brama*	Old buildings and structures	Beetles and other large insets.
10	White breasted Waterhen	*Amauromis phoenicurus*	Paddy fields and wetlands	Larvae and small insects

11	Redwattled Lapwing	*Vanellus idicus*	Rivers, Farms and wetlands	Grubs and terrestrial insects
12	Indian roller	*Coraclus Bebgalensis L.*	Rice fields	Grubs, caterpillars and pupae
13	Quail	*Coturnix coturnix L.*	Sorghum and pulses	Caterpillars of Lepidoptera
14	Starling	*Sturnus vulgaris L.*	Sorghum and maize	Caterpillars of Lepidoptera
15	Partridages	*Francolinus Sp.*	Agricultural land	Grubs, caterpillars
16	Kingcrow	*Dicrurus Adsimilis B.*	Agricultural land	Grubs, caterpillars
17	House crow	*Corvus splendens V.*	Agricultural land	*Helicoverpa armigera, Mythimna separata*
18	Scaly berasted munia	*Lonchuria punctulata*	Rice field	*Mythimna separata*
19	White rumped munia	*L. striata*	Rice field	*Sesamina inferens*
20	White headed munia	*L. maja*	Rice field	*Mythimna separata*
21	Baya Weaver	*Plocus philippinus*	Rice field	*Mythimna separata*

Acknowledgement:

Author is thankful to principal and Management of Bhogawati Mahavidyalaya, Kurukali for providing facilities to carry out the present work.

References:

Black E.R. Davis F.M. and Henderson C.A. (1971). The flicker and the southwestern corn borer in Missiscipi. Proc. Tall. Timbers Conf. Eco Animal contr. Habitat managem.2, 285-292.

Bruns H. (1957). The economic importance of birds in forests. Bird study, 7,192-208.

Chitampalli Maruti (2002). Pakshikosh. Pp-50.

Coppel H.C. and Solan N.F. (1968, 1971). Avian predation, an important adjunct in the supersession of larch casebearer and introduced Pine sawfly population in Wisconsin forests. Proc. Tall Timbers conf. Ecol. Animal Contr. Habitat Management 2, 259-272.

George J.L and Mitchell R.T. (1948). Calculations on the extent of spruce budworm control by insectivorous birds J. Forestry, 46,454-455.

Gibb. J. A. (1960). Populations of tits and gold crests and their food supply in pine plantations. Ibis, 102,163-208.

Knight F.B. (1958). The effect of woodpeckers on populations of the Engelmann spruce bettle. J. Econ. Entomol, 51,603-607.

Massey, C. L. and Wygant, N. D. (1944). Biology and control of the Engelmann spruce bettle in Colorado. U.S. Dep. Agr.Gre, 944.

Sathe, T. V., Jadhav, B. V., Kadam, S. D., Tingare, B.P. and Jagtap, M. B. (2006). Birds as biocontrol agents in Agroecosystems of Satara District. Int. Sym. Biocontl. Biotech, 216.

Stewart, R. E. and Aldrich, J.W. (1951). Removal and repopulation of breeding birds in a spruce-fir forest community. Auk. 68, 471-482.

Sweetman, H. L. (1958). The principles of biological control. Dubuque. Wm. C. Brown.

Tinbergen L. (1960). The natural control of insects in pinewoods 1. Factors influencing the intensity of predation by songbird. Arch. Neerl. Zool.13, 265-336.

Van Vreden and Abdul (1986). Pest of rice and their natural enemies in peninsular Malaysia pp 151. Pudoc Wageningen.

PHEROMONES IN ANTS: SHORT NOTE

Nilima M. Kankale

Department of Zoology,

Ghulam Nabi Azad Arts, Commerce and Science College, Barshitakli, Dist. Akola (M.S.)

Corresponding author E-mail: drnmpatil74@gmail.com

Pheromones are a chemical that is produced by the internal animal body and released into the environment by one organism and affects the behavior of another organism of the samespecies. Pheromones are chemicals produced as messengers that affect the behavior of other individual of insect or other animals. It has been found that Pheromones may convey different signals when presented in combinations or concentrations. Pheromones differ from sight or sound signals in a number of ways.

Pheromones differ from some other types of chemicals used as signals from one animal to other animals. Ants produce alarm pheromones in the form of formic acid from the abdomen to protect themselves from enemies. Bonnet in 18th century discovered the long trails of ants. The ants moved to and free along a definite track, none of them diverting from it. They waved their antennae in the air and trapped them on the ground, gradual crowding of ants on both sides of the line he assumed that the path of ants was actually a trail of chemicals which the ants was actually a trail of chemicals which the ants could sense and follow.

The Social behavior of ants is controlled mainly by pheromones. They also use the General social behavior, visual and auditory signals. But most of their signalling in ants and other is lay means of smell (pheromones). Not only mating is controlled pheromonally in ants, but also finding and exploiting food. Different kinds of ants leave trails from different types of pheromones releasing organs. Solenopsis releases its trail pheromone from its Pavan's gland, myrmica from its poison gland, lasius from its rectal gland, myrmica rubra, having laid its trail from its poison gland, attracts its nest mates back to food with a pheromone from its Dufour's gland So, the number of different types of ants se the different pheromones for its routine life of their journey.

References:

https://www.si.edu/spotlight/buginfo/pheromones

https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/trail-pheromone

Advances in Animal Science Volume I

ISBN: 978-93-91768-21-8

About Editors

Dr. Sujata Magdum is working at the PG Department and Research Center, KTHM College, Nashik has a total experience of 22 years dealing with UG and 15 years of PG teaching. She is Nominee of CPCSEA by Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying, Gout of India (2021). Dr. Magdum is Recognised PhD guide of Savitribai Phule University and under her supervision 4 PhD and 3 MPhil are awarded. 3 more students are registered for PhD under her. Dr Sujata Magdum is recipient of prestigious Madhavi Shyam Award given by ZSI, Bodhgaya (2018) and Best Academician and Researcher award by University of Mauritius (2016).She has published and presented many research papers at National and International conferences and Authored many text books prescribed by Maharashtra state higher secondary Board (2009, 2011) and for undergraduate courses of SPPU, Pune.

Dr. Hema Digamberrao Makne is working as the Head, Department of Zoology, B. Raghunath Arts, Commerce and Science College, Parbhani (M.S.). She has a total 16 years of teaching and research experience. She has published 21 Research papers in reputed journal, 2 Articles in edited books and 8 Papers in International, National conference proceedings. Dr Makne has attended and presented her research work in 23 national and 8 international conferences. She has completed two research projects funded by University Grants Commission. Her area of research includes Parasitology, Environmental Science, etc. She secured highest rank in Masters Degree and received Mehndi Ali Gold Medal for this achievement. She is recipient of two national level awards for her academic and research contribution.

Dr. Rajendra Vishnu Salunkhe is currently working as Associate Professor at Department of Zoology and Head of the Department of Microbology at Arts, Science and Commerce College, Indapur, Dist. Pune. He has teaching experience of 31 years at graduate and post graduate level at Savitribai Phule Pune University, Pune. He has published research papers in leading national and international journals. He is working as a member of examination committee at Punyashlok Ahilyadevi Holkar Solapur University. He has received a 'Best research paper presentation award' at national conference. His biography has been published as 'Herpetologist and Educationist' in Asia-Pacific Who's Who by Rifacimento International, Delhi. He is a life member of Indian Science Congress Association. He has worked on snake research project and submitted to Pune University in 2014. He has massive contribution in the snake rescuing. He rescued 2750 snakes from Indapur tehsil and doing work since 30 years. He is good in bird watching and has collection of 245 bird species identification data from tehsil area.He conducted the certificate courses and demonstrated the college students that how to rescue the venomous snakes at an ease. In his youtube channel 'Dr. Rajendra Salunkhe' many videos are famous for snake rescuing and releasing activities. He is a good trekker climbed many difficult forts.

Dr. Vinda Manjramkar is working as an Associate Professor in Zoology at B. N. Bandodkar College of Science (Autonomous), Thane, Maharashtra. She has 26 years teaching experience. She has completed M.Sc. Zoology (Endocrinology), Ph.D. (Zoology), M. A. (Clinical Sociology), M.B.A, M.Phil. (Rural Development) and Ex-commissioned NCC officer. She has worked as member of syllabus committee (UG and PG) in Zoology of University of Mumbai. Dr. Manjramkar is Member of Board of Studeies in MRS (Masters in Rural Studies), Shivaji University, Kolhapur, Maharashtra, Faculty Advisor CASI MAHA Model, United Nations, WHO, etc. She also contributed as resource persons in various UGC refresher courses at different universities, workshops, conferences, etc. On her name there is one Indian patent and three Australian patents. She is recipient of Samaj Bhushan Puraskar from Thane Pattrakar Sangh, BEQET (team member) Special citation Award, Maharashtra government Merit Scholarship for Ph.D. 1991 to 1993, International Woman's Diamond Jubilee Scholarship, All India 4th Rank holder in NCC precommission course, etc.

Bhumi Publishing

ISBN 978-93-91768-21-8
9 789391 768218