2016

Harare Institute of Technology

Ganges Rd, Belvedere, Box BE 277, Harare
www.hit.ac.zw
communications@hit.ac.zw

Research and Development

HIT Harare Institute of Technology
success through innovation

SCHOOOL OF INDUSTRIAL SCIENCES & TECHNOLOGY

SCHOOL OF ENGINEERING & TECHNOLOGY

[COMPENDIUM OF HIT 200 PROJECTS ABSTRACTS 2015-2016]

The document captures the abstracts of HIT 200 Projects done by students in the School of Industrial Sciences & Technology and School of Engineering & Technology for the academic year 2015-2016

School of Engineering & Technology

Department of Chemical and Process Systems Engineering

THE FEASIBILITY STUDY OF APPLE JUICE MANUFACTURING

[1]T BERU, [2]T CHAGWEDERA, [3]A T CHAKONA, [4]M CHIKUHUHU, [5]M CHIMBGANDA , [6]T. MANGENI

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Currently there is no apple juice being produced in Zimbabwe. This causes high cost in the importation of apple juice by the local companies and this was the driving force behind this project. This project focuses on the feasibility study of the manufacture of apple juice.The proposed plant produces 7 500 litres a day from 10 500 kilograms of apple. The apples grown in Zimbabwe are sufficient as raw materials for the projects. Experiments carried out indicated that above 80% of apple juice can be extracted from raw apples and this was achieved by ultrafiltration. Ultrafiltration enhanced quality and stability of the apple juice. The juice is then pasteurized to increase shelf life to approximately 9-12 months. An economic evaluation was done for the project to analyze its economic feasibility. It has an estimated return of investment of 35.5 % a capital investment of USD$341 610-00 and an annual profit of USD$1 455 603-00 using apple juice price of USD$1, 05. The process is predicted to have a payback period of 3 years.

Keywords: *Apple Juice, ultrafiltration*

FEASIBILITY STUDY ON THE PYROLYSIS OF WASTE TYRES TO OBTAIN FUEL OIL AND CARBON BLACK

[1]W CHEMHURU, [2]G DZAPASI, [3]M DZVOVA, [4]P CHIUTSI , [5]K CHIKWANGURA , [6] MM MANYUCHI

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

The disposal of used tyres generated each year in Zimbabwe into the environment is unacceptable approximately 2.4 million tyres can be disposed each year. A better solution from an environmental and economic standpoint is to thermally reprocess the tyres into valuable products which are carbon black (30-40 wt.%), oil (40-60 wt. %) , steel (10-12 wt.%) and syngas(5-20 wt. %).This report describes the feasibility study on the pyrolysis of waste tyres to give carbon black, pyrolytic oil, steel and syngas as waste products. Experiments were carried out to produce the products of pyrolysis of waste tyre. Experiments were also carried out to test the properties of the products which are viscosity of 42.10×10^{-4} and density of $855 kg/m^3$. The properties were found good when they were compared with the expected properties from theory. An economic analysis was done on the project and the profitability indicators were found favourable. The payback period was found to be 2.5 years and breakeven of 2912 units. The pyrolysis of waste tyres was concluded feasible.

Keywords: *pyrolysis, waste tyres, fuel oil, environment*

FEASIBILITY STUDY ON THE EFFICIENCY OF CO-FIRING BIOMASS IN COAL BOILERS IN ZIMBABWE

[1]MO SIBANDA, [2]S TARUWINGA, [3]L ZINYAMA, [4]R CHANDIMHARA , [5]A FUNGURA

[1-5]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

The need to conserve the depleting non-renewable resources has led to the interest in renewable energy system studies. Most Zimbabwean industries use coal for firing their boilers. Co-firing is a process whereby two different materials are introduced and fired in the same existing boiler.

The main focus for this Research was to test the feasibility of co-firing with biomass in coal fired boilers in Zimbabwe. Two studies were conducted to check for feasibility which include technical feasibility and economic feasibility. In the technical feasibility, types of boilers were evaluated and to check if they are suitable for co-firing and if not what modifications need to be made. The fuel study was evaluated and the main focus was on sawdust briquettes. In Zimbabwe sawdust is mainly available in Mutare as a waste product from the timber making companies. The best co-firing ratio

that was obtained that would not affect the boiler efficiency was found to be 80% coal and 20% biomass. To account for the different calorific values a ratio was obtained and it was discovered that for every kilogram of coal removed 1.5 kilograms of biomass was needed to replace it. At an economic stand point the result that was found was that cofiring is feasible if the biomass is available in the local area that is reducing the transportation cost since biomass is bulky and therefore very difficult to transport.

Key words: *co-firing, biomass, sawdust briquettes, boiler*.

FEASIBILITY STUDY OF THE PRODUCTION OF 18.8 MILLION LITRES PER YEAR OF BIOETHANOL FROM WATER HYACINTH (EICHHORNIA CRASSIPES MARTIUS)

[1]T MAJONI, [2]A MAKWARE, [3]S MAZIVIRE,[4] F MHLANGA , [5]F SAZIYA

[1-5]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Use of fossil fuels has become of great concern as deposits are generally depleting. This has influenced so much research into finding renewable fuel sources which can be alternatives as well as the major sources for the future. Production of ethanol from lignocellulosic material is one such study that has been looked at of late. Water hyacinth is an aquatic weed that has been recognised for its invasive problems but it is also botanically known to be lignocellulosic hence serves as a potential raw material for ethanol production whose demand is increasing above supply in Zimbabwe. This project hence, focuses on the production of ethanol from water hyacinth using dilute acid pre-treatment hydrolysis and saccharomyces cerevisiae fermentation. Experimental work carried out proved that it is technically feasible to produce ethanol from water hyacinth with a conversion ratio of 15%. Material and energy balances were carried out as well as economic analysis in order to determine the practicality of the project. The project has a payback period of 5.5 years and return on investment is at 18%, thus indicating viability of the project from a capital investment of US$57 million.

Keywords: *Water hyacinth, Bioethanol, Biomass, Saccharomyces Cerevisiae, Lignocellulosic*

FEASIBILITY STUDY ON THE ACYLATION OF TANNERY WASTE AMINO ACIDS TO FORM BIODEGRADABLE SURFACTANTS

[1] V MAKADO, [2]N MAKONI,[3] FB MANGO, [4]J MAPHOSA, [5]K MARIJENI , [6]E MAHOFA

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Biodegradable surfactants production has been on the rise to mitigate harmful environmental effects caused by petroleum-based surfactants to produce more eco-friendly products derived through the use of renewable feedstocks. This study aims to reduce land and water pollution caused by huge wastes generated from tannery industries by valorization of this waste to produce biodegradable surfactants. A mixture of surfactants was produced by enzymatic hydrolysis of the tannery fleshings, using pepsin as catalyst and then acylation of the hydrolysate (solubilized amino acid content) using stearic acid. The mixture was heated under cooling reflux conditions at 70°C for 2 hours and then allowed to cool to produce the mixture of surfactants. Further tests were performed to ascertain the physico-chemical and biological properties of the surfactant, including emulsion capacity tests and biodegradability tests. Results observed showed that the surfactant mixtures were easily and quickly mineralized by the aerobic microorganism in the first week of the testing period. Mass balances on the process established that it is possible to produce 6 tonnes of surfactant mixtures from a tonne of fleshings. A payback period of 2.4 years and a capital investment of $215 475.00 were calculated and are good financial indicators for this project.

Keywords: *biodegradable surfactant, tannery, acylation, amino acid, pepsin*

FEASIBILITY STUDY OF THE PRODUCTION OF LIQUID SMOKE

[1]B MARIKI, [2]F NGWENYA, [3]A MPHEPO, [4]EH TAHWA, [5]TG RAKABOPA , [6]N FUNGURA

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

With the growing concern over greenhouse effects as well as health effects, meat processing companies across the globe are shifting from traditional smoking methods to the use of the “green smoke” (liquid smoke) as a way of food flavour enhancement and shelf life stability improvements. Players in the meat processing industry in Zimbabwe, however, import the vital ingredient from Europe as it is not manufactured locally. The feasibility study of the production of liquid smoke from

indigenous hardwood trees was studied. Experiments were done in a laboratory under conditions of slow pyrolysis. A sample of Rhodesian teak with a moisture content of 13.87% was pyrolysed in the laboratory using a laboratory. A gas evolved was condensed to collect an aqueous condensate called liquid smoke. The overall percentage yield of the process was 10%. This finding suggests that indigenous hardwoods might be used to produce liquid smoke for the sustainability of the local meat processing industry. The pyrolysis reported herein had lower heat transfer rates than those achieved in industrial pyrolysis reactor system suggesting similar significant further improvements are possible.

Keywords: *liquid smoke, tannery, hardwoods, pyrolysis*

FEASIBILITY STUDY OF UPGRADING HARARE MUNICIPAL BIOGAS TO BIOMETHANE FOR DOMESTIC USE

[1]*T* MURERWA, [2]T MUNYENGWA, [3]T MTORORI, [4]S MUDUTU, [5]T MUSHAIKE, [6]J GOVHA

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Biogas is a renewable energy source produced from sewage treatment, animal waste and organic waste. The typical constituents of raw biogas are 60-65% methane, 35-40% carbon dioxide, 0.5-1.0% hydrogen sulphide, fractions of water vapour and other contaminants. The generation of Municipal sewage waste has increased over the past years due to the rapid increase in urbanization and growth in population size. Currently at the FIRLE SEWAGE WORKS, HARARE WATER (FSWHW) biogas is being produced in 19 primary digesters of capacity 1400m^3.Each of these digesters produces approximately 1420m^3 of raw biogas every ten days. The biogas produced is being wasted since it is being flared into the air. This study assesses the upgrading of this biogas for its effective utilization for domestic purposes. Flaring of this biogas which contains high concentrations of methane, a powerful greenhouse gas is the motivation behind this research since methane is a source of energy which can be harnessed to alleviate energy shortages in Zimbabwe. Biogas upgrading can be done using different technologies to increase its calorific value. In the research, the different technologies were evaluated and a conclusion was made that the chemical scrubbing method is the most suitable upgrading technique to be used in Zimbabwe. This method shows that 98% of methane can be achieved in the upgraded biogas which is a clean renewable energy source that can be used for

domestic purposes such as cooking and heating. The total capital to be invested into the project was estimated to be $473 760 with a breakeven point of 108 354.3kg and a payback period of 2.24years. This showed that chemical scrubbing is a low cost technology and is economically feasible.

Key words: *Renewable, Utilisation, Upgrading, Calorific value*

FEASIBILITY STUDY ON THE EFFECTIVENESS OF GOLDIX 570 AS AN ALTERNATIVE TO SODIUM CYANIDE IN GOLD LEACHING

[1]G JERE, [2]Y GANGAI, [3]P MUTANDWA , [4]TC MADZOKERE

[1-4]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

The use of sodium cyanide as a leachant has serious environmental and health risks though it remains the main lixiviant in gold extraction. Many countries are advocating for the ban of the use of sodium cyanide in gold mining and to resort to recycling of the commodity. This project investigates the effectiveness of Goldix 570 as an alternative to sodium cyanide in gold leaching. Freda Rebecca Gold Mine process gold ores with an average grade of 2.2 g/t using the CIP set up. Bottle roll leaching tests were carried out in order to determine the leaching kinetics of Goldix 570, the overall gold recovery and to optimise the dosage of Goldix 570. Adsorption tests were also carried out to ascertain the effect of Goldix 570 on activated carbon during adsorption. The leaching kinetics of Goldix 570 was found to be 40.8 % less compared to sodium cyanide. The optimum dosage of Goldix 570 was found to be 1.4 kg/t with a high consumption of lime of 3.75 kg/t. Goldix 570 has no adverse effect on the activated carbon for the recovery of the gold solution. The use of Goldix 570 as a leachant is technically and economically feasible.

Keywords: *sodium cyanide, leaching, goldix*

FEASIBILITY STUDY ON THE REMOVAL OF THE HEAVY ION, COPPER FROM MINE TAILINGS USING HYBRID OF THE SUPERCRITICAL EXTRACTION AND CHELATION PROCESS

[1]V SHAYI, [2]S SAUNGWEME, [3]W MUTATAVIKWA, [4]N NDUNA, [5]A NDLOVU , [6]L KADZUNGURA

[1-6]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Our major objective during the research and development project was to find out the feasibility of removing copper metal ions from mine tailings using a hybrid of the chelation and supercritical extraction processes. The two where separately studied under laboratory conditions, to find out how efficient they are. Chelation uses an organic or inorganic substance that forms a complex ion with the metal in question. We resorted to ethylenediaminetetraaceticacid (EDTA) as a chelate due to its cheap price and the fact that it is organic and non-carcinogenic. Supercritical extraction includes the use of a fluid for example water that is in its Supercritical state to dissolve the metals in it. We used carbon dioxide because it is cheap and readily available and it reaches its supercritical point at a very low temperature and relatively high pressure. Using Mhangura mine(currently not functional) as our basis, we studied its copper content in mine tailings and discovered that it in 1 kilogram of mine tailings there is 0.12kg of the copper ion. We the checked for the moisture content and pH of these tailings, the pH reading was 7, 8 and the moisture content was 0,11%. These experiments helped in identifying the favourable conditions to carry out our process in, using laboratory experiments we discovered that chelation alone using 0,2g/L EDTA was able to chelate 29,49% of the copper ions in a 2g sample of mine tailings. Chelation therefore combined with supercritical extraction yields a higher percentage. After the process the EDTA and carbon dioxide will be recycled after separation by depressurization. We will remove the copper selectively from the EDTA which would have bonded with other unwanted metals by leaching with sulfuric acid.

Keywords: *EDTA, supercritical extraction, chelation*

FEASIBILITY STUDY OF MANUFACTURING PETROCHEMICALS FROM STEEL PRODUCTION GASES RELEASED FROM STEELMAKERS IN KWEKWE.

[1] T HONDO, [2]T MAFANDIZVO, [3]B GAPARA, [4]A GOPITO , [5]M MANYANGADZE

[1-5]Department of Chemical & Process Systems Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Steel production processes typically dispose large volumes of specialty gases. The gases of concern come from the three different processes namely coke oven process, blast furnace processes and the basic oxygen process. At the present moment there are high and ever increasing levels of pollution in the world. This rises from the fact that more pollutant gases like greenhouse gases are being added or released to the atmosphere than those which are being removed by various processes like the natural intake by trees of gases like carbon dioxide for use in photosynthesis. This imbalance between the gases entering the atmosphere and those leaving has led to the greenhouse effect resulting in the increase in global temperature and rising of the sea level due to the melting of the ice glaciers in the North Pole. This has been the main motive that has pushed us and greatly influenced our decision to carry out a research project to cater for these valuable but underutilized gases. These steel production gases mainly consist of methane, hydrogen, carbon dioxide and carbon monoxide all which are vital to the petrochemical industry. This work seeks to study the process of harnessing the waste gases at Steelmakers Company in Kwekwe for use as raw materials in the manufacture of petrochemicals. The extraction of gases like hydrogen, carbon monoxide, and methane in their raw form or "ready to use form" means that the various processes which are involved in the manufacture of these gases won't be necessary thus saving costs and time which increases productivity. Experiments were done to make sure that same raw materials found in Zimbabwe could produce the same results as those from outside and the results obtained we conclude that there is significance evidence to suggest that this research study is feasible and petrochemicals can be manufactured here in Zimbabwe using our own flue gases. From the economic balance the payback period after establishing a fully functional plant of capital investment of $ 607 300.00 will be 1.74 years.

Keywords: *steel, petrochemicals*

Polymer Technology & Engineering Department

DESIGN, SYNTHESIS AND CHARACTERISATION OF WATER PURIFICATION MEMBRANES DERIVED FROM WASTE POLYSTYRENE.

[1]A. MABASA, [2]K. MUSHAYI, [3]M. CHIKAKANO, [4]C.MBANJE

[1-4]Department of Polymer Technology & Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Zimbabwe is currently facing waste management crisis with the city of Harare currently having lost its sunshine city status due to the presence of plastics waste and dirt which litters the central business district. The litter is almost uncontrollable with the sprouting of fast food outlets which use expanded polystyrene as packaging. These food trays ultimately find their way into the streets thereby creating a visual nuisance. This paper reports on the alternative use of waste polystyrene by fabricating an ion exchange membrane from Sulphonated waste polystyrene and biochar. The membrane is capable of exchanging calcium Ca2+ and magnesium (Mg2+) which are contaminants of water. The supported ion exchange membrane was characterised using FTIR and evaluated for cationic exchange capacity in a known Ca2+ containing solution and was found to be performing far better than Waste Polystyrene membrane or biochar alone. The composite membrane was recommended for further structural strength development if it is to be used for commercial applications.

IMMOBILISATION OF TITANIUM DIOXIDE NANOPARTICLES ONTO A PMMA SUBSTRATE FOR PHOTOCATALYTIC DEGRADATION OF ORGANIC DYES DISSOLVED IN TEXTILE EFFLUENT.

[1]T. MUGWAGWA, [2]L. CHARAMBIRA,[3]E. DHLAMINI,[4]W. MATIWENGA, [5]A. MATONGO

[1-5]Department of Polymer Technology & Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Organic dyes present in textile wastewater require removal due to their negative environmental and health effects. Although there are several ways to treat such effluent, this study focused on photocatalytic degradation of dissolved organic dyes using titanium dioxide nanoparticles immobilised on Polymethylmethacrylate (PMMA) substrate fixed onto a slurry bed reactor. The use of suspended nanoparticles for the photocatalytic degradation process poses its own challenges particularly of regeneration of the nanoparticles from the treated water, high costs are encountered and furthermore if the nanoparticles are consumed by humans they are thought to be carcinogenic hence the need to immobilise them. This research is concerned with the immobilizing of the titanium dioxide nanoparticles onto a polymer substrate and the subsequent photocatalytic efficiency of the catalyst after immobilisation. The nanoparticles were immobilised using coupling agents for chemical adherence to the substrate. A slurry bed reactor was fabricated to facilitate the evaluation of the immobilised nanoparticles to determine the impact of bonded surface area on photocatalytic efficiency of the catalyst using methyl orange as a model dye dissolved in water. The immobilised nanoparticles were able to decolourise the methyl orange solution in about three hours

when exposed to artificial UV light source. Further work needs to be done to test the type of bond created between the substrate and the nanoparticles.

POLYMER –MODIFIED BITUMEN FOR ROAD CONSTRUCTION.

[1]T. DEWAH,[2]T. MASHAYAMOMBE,[3]T. MATEMA,[4]T.MASAIRE

[1-4]Department of Polymer Technology & Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

This is a research project on the modification of bitumen using waste plastics. Polyethylene was used in undertaking this research project. The research is mainly based on solving the road potholes problems currently being faced in Zimbabwe at the same time helping Environmental Management Authority (EMA) in ensuring a plastics waste-free environment. The project is trying to improve on work that has been done before elsewhere in the world. The choice of polyethylene was motivated by the fact that since it is a petrochemical product, it would be compatible with bitumen, a petrochemical product as well. The thrust of the research centred on trying to create a strong bond between aggregates and the bitumen for strength and long term road performance. Epoxy resins were incorporated as coupling agents to enhance strong bonds between bitumen and aggregates. The results were satisfactory although work needs to be done to ascertain bond strengths.

DEVELOPMENT OF A SELF- CLEANING HYDROPHOBIC SURFACE.

[1]P. MUSHONGA,[2]C. MACHIWANA,[3]B. DZVINGWE,[4]C.CHIBANDA

[1-4]Department of Polymer Technology & Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Cleaning surfaces at heights for example in sky scrapper buildings, shackle insulators on electrical power lines and roof tops of motor vehicles such as big trucks and buses has been a risky job which resulted in many injuries and deaths. Machinery to clean these surfaces is available, however, it is very expensive to purchase, thus making them almost unavailable in developing nations such as Zimbabwe. Other cleaning facilities involve the use of surfactants to clean the surfaces but these chemicals have negative effects to the environment. It is a plethora of these problems that led us to the development of a self-cleaning hydrophobic surface which can be used in vast applications but not limited to ceramic tiles for walls, windows, shackle insulators and motor vehicles. Self-cleaning hydrophobic surfaces are cheaper, durable and environment friendly. They only need water to roll on their surface and all dirty can be carried away as a ball. Polymer-based materials locally available

were utilised in coming up with the hydrophobic surfaces. The products clearly showed that the created surface was able to cause water to roll off with dirty than the one that was not hydrophobic.

Industrial and Manufacturing Engineering Department

OPTIMISATION OF MATERIAL HANDLING SYSTEM: LOBELS PVT LTD

[1]N. MANDINYAYA, [2]P. CHAKONDA, [3]P. CHIPONDA, [4]R. SANDU

[1-4]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

This project gives a detailed analysis and redesign of a loader pusher. The design parameters were investigated in accordance with industry standards and recommended practices for use in industrial and food processing factories. The belt and clutch system of loading dough at LOBELS PVT LTD experiences frequent breakdowns thereby exposing the dough to contamination and the cost of production is also increased. The aim of the project was to redesign a loader pusher which does not experience frequent breakdowns. Sources of data which were used include primary and secondary data, fatigue analysis was done on most critical sections of the frame. Bending stresses were calculated which showed proper bending strength in the rollers and buckling in the struts.

Keywords: *Loader Pusher, Belt, Clutch, Fatigue Analysis, Bending stresses*

DESIGN OF A WATER LEVEL DETECTOR

[1]M. MATUKU, [2]N. GANDIWA, [3]G. NYAMUZIHWA, [4]T. MUTEPFA, [5]T. CHIRAIRO

[1-5]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

This study sought to develop an automated water dosing system concentrating on the pH property of the water for domestic use. The project was motivated by the observation that some underground water sources contain cations and anions that alter the hydrogen ion concentration thereby offsetting the safe pH range for drinking water. Data was collected from experiments on some neutralizing agents for open source water, with the limitations and advantages noted. In essence, an automated water neutralizing system was developed, whose aim is to assist in homes and community well systems. The researchers recommend that the system be developed further to cater for solids and material that may affect the physical quality of the water like colour and odour.

Further experimentation and research on the project is to be done to ensure it is not harmful in anyway.

Keywords: *Hydrogen ion concentration, Open source water, Water neutralising*

DESIGN OPTIMISATION OF A RAW MATERIAL PROCESSING MACHINE FOR TOOTHPICK PRODUCTION

[1]V. MABASA, [2]L. NJOKOYA, [3]A. MARUFU, [4]C. MAGOSO, [5]T. BVAKACHA

[1-5]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Zimbabwe is incurring a hefty importation bill of about $215 000.00. Local Hotels, restaurants and households import toothpicks in large quantities due to the absence of locally produced toothpicks. The researchers came up with a bamboo processing machine in preparation for toothpick production which reduced material handling and processing time as compared to available designs. Design standards were applied leading to a prototype being made. This technology transfer project combines a cross cutter unit and the splitting machine.

Keywords: *Toothpicks, Bamboo processing, Material handling, Technology transfer*

DESIGN OF A WIRE NAIL MAKING MACHINE MECHANISM

[1]A. SIAMAINDI, [2]G. CHITAURO, [3]A. ISAYA, [4]M. SANTUNGWANA

[1-4]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

The objective of this research was to design a nail making machine mechanism and simulate the model. The machine is cost effective and most ideal for local SMEs. An evaluation of machines currently available in Zimbabwe was done to establish their cost of purchase and source. The main thrust of the project was to design a machine which is more productive in terms of volume and reliability. In this project the machine was redesigned locally to substitute imports and tested to evaluate the mechanics behind its motion

Keywords: *Nail Making, Redesign, Import substitution*

DEVELOPMENT OF A LIVESTOCK SPRAY RACE

[1]T. KUFUMIRA, [2]M. GORERINO, [3]T. PFUPAJENA, [4]S. MUTAMBA, [5]E. MUDZENGERERE

[1-5]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

Plunge dipping of livestock is time consuming and the dips are located at a distance from most of the farmers. The process of preparing for the dipping requires a lot of water which is usually difficult in areas where there is a scarcity of water. The researchers sought to design a spray race which can be used at an individual farm setup, uses minimal water and reduces amount of labour required in setup. The spray race optimises the chemical mixture and minimises the amount of water needed. The spray race will also feature a low energy consuming pump which can be powered by solar energy.

Keywords: *Spray race, Livestock, Chemical mixture*

DESIGN OF A CRACK DETECTION ROBOT

[1]L. GUSHUNGO,[2]W. MUSARIRI, [3]C. NDORO, [4]E. MASHAYAMOMBE,[5] I. VENGAYI

[1-5]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

This project is a design of a weld crack detection robot. The function of the robot will be to inspect quality of welds by detecting internal cracks. The robot was designed in accordance to machine design principles. The robot will detect cracks using infrared transmitter and receiver circuit giving output of light when there are cracks. The design will serve as a stepping stone in ensuring the quality of welds at low cost in Zimbabwe. Design and analysis tools such as AUTOCAD, MULTISIM were applied.

Keywords: *Weld cracks, Inspection Robot, Infrared*

DESIGN AND DEVELOPMENT OF A HEAT EXCHANGER FOR SOLAR THERMAL STORAGE APPLICATIONS

[1]G. MASAMA,[2]T. KANEMBIRIRA, [3]N. NYADETE,[4] K. MAFEKING, [5]E. MAZHATA

This project is intended for the design of a solar thermal storage heat exchanger system that will reduce the problem faced by current air based solar heat exchangers due to weather constraints such as slight cloud cover rendering them ineffective for the period of time in hot water production. A shell and tube closed loop design was adopted with a heat transfer fluid that has a relatively high heat retention. The solar collector is a parabolic dish with an aluminium foil reflecting surface and transmission oil is used as the heat transfer fluid. The heat exchanger system design is environmentally friendly and will only cost us$200 to manufacture.

Keywords: *Solar Thermal, Heat Exchanger, Closed loop design*

DESIGN OF AN OXYGEN LIFTING MACHINE

[1]I. MUSIYIWA, [2]G. MAGAISA, [3]T. MAZADZA, [4]T. MAPIKI, [5]M. MASHINDI

[1-5]Department of Industrial & Manufacturing Engineering; Harare Institute of Technology; Ganges Rd, Belvedere, Box BE 277, Harare

The lifting of gas cylinder bottles currently is being done manually and it involves a high level of risk of injury and explosion. The research scope of this project was limited to the needs of Harare City Council clinics and pharmacies. Interviews and consultations were carried out in order to determine the type of product that had to be made. The designed unit is powered by a hydraulic pump which initiates the clamp pads to grip or release a cylinder.

Keywords: *Gas Cylinders, Hydraulic unit, Clamp pads*

Electronics Engineering Department

TRAIN TICKET VENDING MACHINE USING FPGA

[1]PARADZA LESLEY,[2]MTISI SHADRECK,[3]MUSHANGURI VELTON,[4]MUCHEHIWA HAROLD

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The purpose of this project was to design and develop a system capable of selling a train ticket to the customer without the aid of a cashier. The customer would select his or her destination and insert money equivalent to the destination. The controller would count the money then calculates change if any then printout a ticket. If the amount is not enough the controller asks for more money. The system was developed to reduce the problems of robbery as it stores the money after a transaction until it is collected by the by the administration. This project report provides the steps undertaken in developing and the system using Field Programmable Gate Array. (FPGA).

TOUCHSCREEN AND BLUETOOTH BASED LINE FOLLOWING ROBOT

[1]CHIMBOZA WALLACE,[2]CHIRESHE HENRY,[3]MBAVHA TAWANDA,[4]ZABA BLESSING

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

These days efficiency is of essence in industry and even in homes, sometimes it is also important to have efficiency even in the most hazardous of places where human cannot tread. In this project a prototype for a Bluetooth enabled line following robot was designed and built to effect this. A Bluetooth enabled line following robot moves automatically from point A to B following a black line on a white surface with minimum human intervention and can be interrupted by the user using a mobile phone. The code for the microcontroller was written using MikroC language on MikroC pro for pic. The android application was developed on MIT app inventor site. The circuit for the project was first designed and tested on Proteus and it behaved as expected. The PCB for the project was then developed. The robot behaved as expected in mobile phone mode, the signals from the phone were successfully executed. However in the sensor mode the robot did not behave as expected. For future recommendations pulse width modulation technology have to be used and an ultrasonic sensor have to be used to detect obstacles in front of the robot.

SECURITY SYSTEM USING SMART CARD TECHNOLOGY

[1]MOYO NKOSILATHI,[2]MUPAZI LLOYD,[3]MUTENDERA YEUKAI,[4]NZIRAWA KUMBIRAI

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Over the years, several security measures have been employed with the main aim of combating the menace of insecurity of lives and property. This is done by preventing unauthorized entrance into buildings through entrance doors using conventional and electronic locks, discrete access codes, badges and magnetic cards. All these have the same basic disadvantages, as they can easily be duplicated, stolen or passed on, thus allowing unauthorized persons to gain access. In this project, a door security system was designed to allow the privileged user to access a keyless door, where a valid smart card and passcode will guarantee entry. The model prototype consists of a hardware module and software which provides a functionality to allow the door to be controlled through the authentication smart card and passcode by the microcontroller unit. These components were tested on a breadboard and populated on a 10x10 copper board. When a 9V battery was connected to the circuit, the LCD displayed enter smart card. On bringing closer a smart card to an RFID smartcard reader, the LCD displayed enter passcode after the microcontroller communicates through the virtual terminal of UART. If the correct was entered, a servo motor turned 90 degrees for 20 seconds. A buzzer sounded upon entering three unsuccessful trials and the system locked.

POWER MANAGEMENT SYSTEM WITH AUTOMATIC LOAD SHEDDING

[1]MUSABAYANA WILFRED,[2]NYAKUDYA PERKINS,[3]KWANGWARE MORRIS,[4]MANYURAPASI DUDZAI

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Electricity drives almost all activities be it at home or industry and thus it is necessary to manage and use it efficiently and effectively. Users especially at households use most electricity during peak periods and this increases demand thus utility company might fail to supply as required. The purpose of this project is to design a control system that monitors and regulates the consumption of electricity by switching off certain loads that are of less importance during a certain period of the

day. The system was designed using PIC16f877A microcontroller which was interfaced with a current sensor thereby calculating power in KW. Relays were used to switch ON and OFF the load, using a relay driver and for notification purposes an LCD, LEDs and a buzzer were used. The circuit was designed using Proteaus software and the code was written in microC.

DESIGN AND IMPLEMENTATION OF A TEMPERATURE BASED FAN SPEED CONTROLLER USING A MICROCONTROLLER FOR HOME APPLICATION

[1]TAZVIVINGA CLEMENTINE,[2]ZAWAIRA REGINALD,[3]SIBANDA MAX,[4]RUSAMU RAPHAEL

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The project concentrated on table fans and small fans used in computers. Pulse width modulation was at the core of this project and it was used to control the speed of the motor with the PIC16F877A as the processing unit. The main purpose of the system is to able to alter fan speed to a certain degree automatically depending on the set temperature using pulse width modulation. The system comprises of a keypad to allow the user to set the desired temperature to maintain, an LCD is also incorporated and it acts as an interface to display the set temperature, the recorded temperature and to display weather the fan is on or off. The system accepts data from the LM35, passes the data through an ADC and then compare it with the set temperature or default temperature to control the speed of the fan using PWM. The system was tested on the breadboard and it was successful. The PCB design was not successful, unfortunately the LCD did not display what it was supposed to display.

DESIGN AND IMPLEMENTATION OF MICROCONTROLLER BASED ELECTRONIC QUEUE MANAGEMENT SYSTEM

[1]SIMBO GIDEON,[2]MZEMBI TINOTENDA,[3]DEREMBWE THABISO,[4]BIKORIMANA ERIC

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The microcontroller based electronic queue management system provides a perfect solution for the long and strenuous queues that are currently plaguing Zimbabweans as they try to acquire documents such as passports, IDs and death certificates etc. GSM technology allows the system to send and receive text messages, therefore allowing people to register in the virtual queue and get a reply immediately. The web page developed using HTML also enabled users to register in the virtual queue via the internet. This means that one can join the virtual queue from anywhere at a negligible cost. A program written in mikroC interfaced the GSM SIM900a modem and web page to the PIC16F877A microcontroller and controlled the activities of this system. The replies sent to people wishing to join the virtual queue contain the time of the scheduled appointment and a token which is a proof of registration. This completely eliminates all the strain and inconveniences of physical queues.

FPGA BASED PARLIAMENT VOTING SYSTEM

[1]CHINYAMA TAWANDA,[2]CHIUTSI DESIRE,[3]KUFAHAKURAMBWI PREDICTION,[4]MASHURA BRIGHTON

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The project aimed to design an FPGA based parliament voting system. This system allows two voters to vote at the same time. Also the system allows voters to vote between two options. Using the same system the results of a poll can be retrieved instantly at the end of a poll. Access to the system requires different security keys for both voting and result retrieval. The system was targeted for use by the Zimbabwean parliament so as to address the weaknesses in the voting system which is currently in use. Compared to the current system of voting the system designed in this project is faster and secure. VHDL programming language was used in programming and the system was implemented on an Altera De2 board for prototype purposes.

DESIGN AND DEVELOPMENT OF A MICROCONTROLLER BASED ROOM TEMPERATURE REGULATING SYSTEM USING TOUCHSCREEN

[1]WILLDOM KAHARI,[2]DOUGLAS GWEERA,[3]ROBSON NDORO,[4]CHRYSOSTOME DUSENGUMUKIZA

[1-4]Department of Electronics Engineering, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The aim of the project was to a build a microcontroller based room temperature regulating system using touchscreen. The hardware was based on a set of components mounted on the PCB. The system was to be controlled by a touchscreen panel with the program residing in the microcontroller. The temperature sensor used in this project was the LM35 temperature sensor. The data from the LM53 passes through the Analogue to Digital converter which samples the data to digital data. The microcontroller would use this data to manipulate the appliances with respect to the input from the LM35. Output signals from the microcontroller would the heater and/ or fan to regulate the temperature. The transformer stepped down the voltage to 16V and two power supplies 12V and 5V emerged by regulating the stepped down voltage to provide the necessary power for the microcontroller, and the appliances. The electronic circuit was designed with the

computer aided design tool Proteus 8. The microcontroller software was written using the C language using MikroC PIC development software

School of Industrial Sciences & Technology

Department of Biotechnology

IN SILICO CHARACTERISATION OF AFRICAN SWINE FEVER VIRUS (ASFV) AND STUDY ON ITS MUTATION RATE

MICHAEL MADZINGA[1], CARLTON MUSHORIWA [2], PRAISE CHUDU[3], MASIMBA MANDEYA[4], CEPHAS MAWERE [5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The aim of this project was to ascertain the antigenic site and variation of the p72, p54 and p30 structural proteins in order to recommend for vaccine production for African swine fever virus (ASFV). ASF is a highly contagious and fatal viral disease of pigs caused by a DNA virus, ASFV. It has resulted in economic devastation in the agricultural industry by the death of thousands of pigs. Currently there is no vaccine for the ASFV. Molecular characterization of this virus takes long thus an *in silico* approach was used. Multiple sequence alignment was done for CP204L, E183L and B646L

genes from 11, 17 and 10 isolates of ASFV and Phylogenetic analysis was conferred on the aligned sequences by maximum likelihood using MEGA software. Protein variability indexing was then done using the Wu-kabat and Simpsons variability plots. Modelling of 3D structures of the proteins p30, p54, p72 and DNA polymerase X were done using Phyre, Swiss, Raptor X and Sparks servers and 3D model evaluation were done using RAMPAGE and the models with the highest percentages were viewed using Pymol. Ellipro server was used to predict antigenic sites, the predicted linear epitopes with the highest protrusion index values were mapped on the respective 3D structures using UCSF Chimera. The phylogenetic trees showed that despite the variations between the ASFV isolates and the location of their occurrence some of the isolates are related. Homology modelling of the p30, p54, p72 proteins and DNA polymerase X was done and the β pleated sheets, α helices, coils and epitopes on the proteins were labelled. The predicted linear epitopes on p30, p54 and p72 proteins had 18, 33 and 12 amino acid residues respectively. These results can be used to aid in the development of a vaccine and designing of an immunodiagnostic tool for ASF.

Keywords: *African Swine Fever; Phylogenetic analysis; Protein Variability Indexing; Homology modelling; Vaccine development*

DESIGN OF A BIOMEDICAL ELECTRONIC HEALTH DATABASE FOR EFFECTIVE PATIENT MONITORING, HEALTH DELIVERY AND RECORD PROFILING

VARAIDZO MUKWEKWE[1], TAFADZWA MUTANGA[2], WADZANAI MWELULA[3], BLESSING MATENDE[4], CEPHAS MAWERE[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Patient monitoring mechanisms still suffer from problems like high doctor-patient ratio, medical data fragmentation, loss of information, blurred images and being administered to drugs that one has an allergic response to due to lack of adequate prior knowledge of a patient's medical history or indirectly due to misinterpretation of prescriptions as a result of unclear handwriting. The bulk of these challenges emanate from the conventional use of Paper Based Documentation System. This project aimed at designing a Biomedical Electronic Health Database as a Translational Bioinformatics application to address the stated challenges which were clearly revealed after conducting a case study of two primary health care settings, Harare Institute of Technology clinic (HIT) and Belvedere Technical Teachers College (BTTC). The software's used were WordPress for content management, MySQL database and Xampp local web server. A student clinic portal was created for a sample of 32 second year Biotechnology students which consisted of the students personal details such as full

names, registration number, a clinical history, the consulted doctors and special medical conditions. This information was initially combined on a Microsoft Access database which has information tables that can be normalised to enable easy addition of data at any given time. Other useful features such as healthcare articles from various fora such as SayWhat and the Biotechnology department were incorporated via Themekiller plugins that were offered by WordPress. The designed Biomedical health database was able to serve as a medical record storage source, research and patient monitoring tool that proved to be viable in reducing the use of paperwork in recording patient information.

Keywords: *Patient Monitoring; Biomedical Electronic Health Database; Translational Bioinformatics; Student Clinic Portal; WordPress*

MICROPROPAGATION OF *OPUNTIA STREPTACANTHA LEM*

FAITH NYONI[1], RUTENDO KADZUNGE[2], NYASHA MUNGOFA[3], GRACIOUS MAPIRAVANA[4], PATIENCE CHIUNZI[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The use of different concentrations and combinations of plant growth hormones, α-naphthalene acetic acid (NAA) and 6-Benzylaminopurine (BAP) was investigated in this project. Other factors like the type of explant and the suitable disinfection protocol were also investigated. The seeds of *Opuntia streptacantha lem* often exhibit dormancy, a phenomenon that prevents germination when the availability of water is reduced. Cactus species generally exhibit a low growth rate and this makes their propagation difficult. As cacti species are much appreciated as ornamental plants due to their great variety and diversity form, they are collected in their natural habitats leading to the endangering of the plant. Plant tissue culture is the main technique that is used to help facilitate the propagation of *Opuntia streptacantha lem* over a shorter period of time than conventional techniques used for commercial purposes. The explants were surface disinfected and then cut using sterile equipment. Segments of a suspected healthy young cladode with one areole were cultivated in Murashige and Skoog medium that was supplemented with different growth hormone concentrations so as to initiate the micropropagation process. Some of the explants were seen to turn brown (10.4%), some were contaminated (25%), while some where healthy and uncontaminated (72.9%). All the uncontaminated explants showed to be healthy and surviving, as shoot proliferation was observed in some growth hormone combinations. Shoots were seen to

develop after some weeks of cultivation, and the 5mg/l BAP and 0.5mg/l NAA combinations showed the most number of shoots that is 11 shoots and highest shoot length of 9mm.

Keywords: *Opuntia streptacantha lem; Plant Growth Hormones; Disinfection Protocol; Explants; Plant Tissue Culture; Shoot Proliferation*

INVESTIGATING *FASCIOLOPSIS BUSKI* AS A RISK FACTOR FOR CANCER

ANGELA KANDEYA[1], TONNY BEKETE[2], DIONNIE MATIMURA[3], SEAN MANDEYA[4], JOSPHAT KUTYAURIPO[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Fasciolopsis buski (a known chronic inflammation agent that damages DNA and causes cancer) is investigated as a risk factor for cancer. This research focused on determining the prevalence of intestinal flukes in cancer patients. Specifically the prevalence of *Fasciolopsis buski* in a selected sample of patients was investigated. The investigation was necessary to ascertain whether the presence of flukes causes cancer and has an effect on effectiveness of cancer treatment. Current cancer treatment methods mostly cause recurrence of cancer and *Fasciolopsis buski* is suspected for the reinfection. Blood and tissue samples from 30 cancer patients obtained by Lancert clinical Laboratories were analysed. Histopathological microscopic examination of liver tissue for lesions, fibrosis, necrosis, granuloma and cholestasis as indicators for *Fasciolopsis buski* infection were conducted. Confirmatory blood tests were also conducted to ascertain *Fasciolopsis buski* infection, using presence of blood markers for chronic inflammation [High-sensitivity C-reactive protein (HS-CRP), tumor necrosis factor alpha (TNF-α), interleukin-1 beta (IL-1β), IL-6 and IL-8], cholestasis, eosinophilia and liver injury. A prevalence of 3.3% parasitic infection was established. No *Fasciolopsis buski* infection was observed in blood and tissue samples obtained from 30 cancer patients. Instead 01 *Schistosoma* and 01 human papilloma virus infection were observed. There was no sufficient evidence to conclusively associate *Fasciolopsis buski* to cancer infection. It is recommended that the prevalence of parasitic infection in cancer and non-cancer patients be investigated using a larger sample for conclusive results. There is need to intensify analysis of samples to screen for flukes besides *Fasciolopsis buski* due to the observed prevalence of *Schistosoma* and Human papilloma virus infection in cancer patients. The research should be done

over a long period of time, with approval from the ethics council to directly collect samples from patients.

Keywords: *Fasciolopsis buski Infection; Cancer; Histopathological Microscopic Examination; Schistosoma; Human Papilloma Virus Infection*

AN EVALUATION OF THE FEASIBILITY OF USING DECOMPOSED CHICKEN FEATHERS AS A POSSIBLE BIOFERTILIZER

ADRIAN MUSENGI[1]; EUGENE CHIROMBO[2]; MITCHELLE MUKUMBA[3]; PRINCE MAGOGO[4]; AMOS MUSENGI[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The present study, focused on the degradation of chicken feathers (feather meal) through the use of natural micro flora found in chicken excrete, determination of the optimum pH for which feather decomposition rate is most suitable and determining whether the products from the decomposition process could be used as a possible biofertilizer. The fermentation was setup by subjecting a 48 hour incubated starter culture into a conical flask containing 12.14g of feather meal. The starter culture was formulated by inoculating chicken excrete suspension in nutrient broth and was then incubated at 37oC. Eight fermentation vessels were allowed to ferment at different pH values (7.2, 8.5 and 9.5) with regular monitoring using a digital pH meter. The pH in the fermentation vessels was maintained by the use of 0.01M sodium hydroxide and 0.01M hydrochloric acid. Fermentation was allowed to run for five weeks at 55oC in a closed water bath. The degradation of chicken feathers was assessed through the changes in the fermentation mixture state and the changes in nitrogen, phosphorus and potassium content throughout the duration of the fermentation process. A gradual increase in nitrogen content in all the fermentation vessels was observed. The vessels at pH 8.5 and 9,5 showed complete liquefaction of feathers after two weeks and lastly the one which had a pH of 7,2 in week three. The product of feather degradation showed capability for trial as a biofertilizer. To our knowledge, this is first report recommending the use of fermented feathers as a biofertilizer. The product of feather degradation showed capability for trial as a biofertilizer due to high nitrogen, phosphorous and potassium content obtained (N (11.12%), P (0.78%), K (0.24%) in at pH 8.5 as final results) in comparison to other biofertilizers.

Keywords: *Chicken Feathers; Feather Decomposition Rate; Fermentation; Biofertilizer*

ISOLATION AND EVALUATION OF *BEAUVERIA BASSIANA* AND *METARHIZIUM ANISOPLIAE* ON HOUSEHOLD AND AGRICULTURAL INSECTS (COCKROACHES AND ANTS) FOR POSSIBLE DEVELOPMENT OF A BIOPESTICIDE

DEBRA BORERWE[1], RUBY KAPENDE[2], KUDZAI MARINDIRE[3], TSITSI PAULOS[4], EUNITA CHIDZIYA[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The main aim of this project is to isolate fungi *Beauveria bassiana* and *Metarhizium anisopliae* from the soil in order to use them in combination as an insecticide in agriculture and households. The insecticide is biological and thus harmless to both the environment and human health and is intended to replace chemical insecticides currently in use as they are non-user and environmentally friendly. In Zimbabwe, agriculture is the backbone of the economy and the main thrust of the agrochemical industry and thus the use of biocontrol agents directly influences the economy. When chemical pesticides are introduced into the environment, they disrupt the balance of the ecosystem by killing other untargeted insects as well as leaving residual toxins in water bodies as well as in the soil and this may be because most of the chemicals are non-biodegradable. In households, the chemicals become toxic when inhaled or when there is extended skin contact with them and thus the need to develop alternative means of addressing the pests within households and agriculture. The biocontrol agents, fungi, are found in soil and thus can be isolated from the soil using the Galleria bait method which uses wax moth (*Galleria mellanola*) larva that are highly sensitive to the fungi quickly becoming infected. Different soil samples were collected from Domboshava, Waterfalls and Belvedere and the wax moth larva were exposed to these soil samples to bait the fungi. The larva baits were then cultured in petri dishes containing damp cotton wool where some of the larva developed into pupa, adult and some were infected developing the characteristic white muscardine disease and eventually dying. The white muscardine from the infected wax moth larva was inoculated in potato dextrose agar with yeast extract and subsequently exposed to ants and cockroaches which died starting from day two and day six respectively. The cadavers were then exposed to a humid environment to encourage spore formation showing that the fungi were the causative agents for the mortality. The project shows the possibility of development of the fungi as bio-pesticides targeting a wide range of agricultural and household pests.

Keywords: *Beauveria bassiana, Metarhizium anisopliae, Bio-pesticide, Galleria Bait Method*

COMPARATIVE NUTRIENT ANALYSIS OF VERMICOMPOSTING USING A COMBINATION OF WATER HYACINTH AND OTHER DIFFERENT ORGANIC SUBSTRATES

CAROLINE CHINDONDO[1], DILAN MAPETA[2], ISHMAEL CHIKEYA[3], PRINCE CHINHEYA[4], THARMARY SENGUDZWA[5]

[1-5]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

Water hyacinth is causing blockage problems in local water bodies thereby hindering recreational activities as well as increasing the water purification costs. Currently there is improper organic waste disposal into the environment which triggers many diseases. In this project, vermicomposting was done to produce a biofertilizer using a combination of water hyacinth and different organic substrates which are disposed as wastes. The organic substrates used were: kitchen wastes, cattle manure, maize stalk and vegetable wastes. Wooden boxes were constructed and two treatments with a control for each combination were made. The control did not have earthworms. During the sixty day period of the vermicomposting process parameters such as pH and temperature were measured at ten day intervals. The pH ranged from 7 to 8.3 and the temperature ranged from 17^{o}C to 31^{o}C. Nitrogen, phosphorus and potassium were determined using Kjeldahl method, atomic absorption spectrum method and Murphy-Riley method respectively. The combination of water hyacinth, cattle manure and kitchen waste had the highest nitrogen, phosphorus and potassium (NPK) content of 1.91, 0.26 and 0.50 respectively. Therefore vermicomposting can be used to manage the noxious weed and organic wastes within the environment thereby producing a valuable biofertilizer.

Keywords: *Water Hyacinth, Improper Organic Waste Disposal, Vermicomposting, Biofertilizer*

A COMPERATIVE INVESTIGATION OF THE EFFICACY OF ULTRAVIOLET LIGHT IRRADIATION AND CALCIUM HYDROXIDE ($Ca(OH)_2$) ON WATER DISINFENCTION

[1]NYASHA MUTYANDASVIKA,. [2]SHAMAINE MAFIKA,. [3]WENDY KAWENGA,. [4]LISA MAZARURA

[1-4]Department of Biotechnology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The project aimed at investigating the efficacy of ultraviolet light radiation and calcium hydroxide on water disinfection. Water is a valued natural resource for the survival of all living organisms. Management of the quality of the water is of great importance. In this study fresh water samples from various rivers and wells were aseptically collected and analyzed for the presence of bacteria, through the use of a spectrophotometer at different wavelengths of 660, 630 nm and 600nm. The fresh water samples were also cultured in Nutrient agar using the pour plate method. The initial spectrophotometric results, for the river water at 660 nm was found to be 0.564 and 0.488 at 600 nm. The spectrophotometry results before treatment of the samples for the well water at 660nm was found to be 0.550 nm and at 600 nm was found to be 0.478. The cultures were placed in an incubator for 48 hours. The water was put into 500 ml Polyethylene Terephthalate bottles (PET), for treatment with lime and UV. The eight bottles were then placed in the sun at for a total of six hours. At two hour intervals the samples were collected and subjected to the spectrophotometer to measure the optical density. After six hours of treatment samples from treated water were cultured on MacConkey agar and incubated for 48 hours. The spectrophotometry results obtained showed that the river water obtained decreased wavelengths of 0.470 to 0.449 and a wavelength of 600nm and a wavelength ranging from 0.464 to 0.452 of the well water, after 6 hours. The samples were then run at a different wavelength of 660 nm and the results obtained for the river water showed a decrease from 0.549 to 0.535 and well water had a decrease from 0.527 to 0.512.The results obtained showed an overall decrease in microbial load after treatment, showing that this method is effective for treating water.

Keywords: *Water Disinfection; Ultraviolet Light Radiation; Spectrophotometric; Microbial Load*

Food Processing Technology Department

DEVELOPMENT OF COCOYAM BREAKFAST FLAKES

[1]O. MUNYAKI, [2]G.C. GUMBO, [3]T. MUDHARA, [4]F. SHENJE, [5]R. SAUTI, [6]C. MUGADZIWA, [7]J. NDIKUDZE

[1-7]Department of Food Processing Technology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

A project was done on the development of breakfast flakes from cocoyams. The idea was to formulate the steps and procedures in the flake production and adopt the most suitable on one in the development of the gluten free breakfast flakes from cocoyam. The group members found a gap in production pertaining to the underutilisation of the cocoyams and sought to diversify and at the same time introduce a gluten free product into the market. Cocoyams are aroid crops grown in marshy areas and are root tubers. They are high in digestible starch and other minerals with relatively high sodium to potassium ratio. Five trials were done, grits were used in the first trial and paste in the second trial. In the 3rd ,4th and 5th trials a combination of paste and grits was used. The product quality kept improving until the final trial when a moisture content of 3.005 was achieved from 1%, 5.2%, 2.8% and 3.012% in the 1st ,2nd, 3rd and 4th trials respectively. The sweetness of the final product was reduced and the hydration properties improved from bad to good to very good. The most acceptable trial was the 5th trial in which the moisture content was 3.005%, the hydration properties were very good and sweetness was good. The cocoyam breakfast flakes were also not too sweet and the colour was golden brown.

PRODUCTION OF A COW PEA SAUSAGE

[1]K. MAKAZA, [2]N. MANYUMWA, [3]A. CHIMERI, [4]G. RUNDORA, [5]B. MARUMBWA, [6]A. MUSENGI

[1-6]Department of Food Processing Technology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

The study was carried out based on the aim of producing a dried cowpea sausage as a source of concentrated protein. Cowpeas are leguminous plants that belong to the Vigna Unguiculata taxonomy. The extraction process was done using an alkaline (NaOH) as the solvent for carbohydrate isolation. Several trials were carried out while varying the steeping time. To neutralize the extract acetic acid was used. A paste was then made of a solution containing protein, lipids, minerals, and the remaining carbohydrates. Additives for flavoring were added to the paste which was then dried partially using a microwave oven. The dried paste was stuffed into cellulose casings and the cooked in a force draft oven. The best viscosity resulted from the solution that was steeped in sodium hydroxide for the least hours. It was concluded that domestic processing techniques like soaking and cooking have a significant effect on the carbohydrate and mineral content of cow pea. Processing of cowpeas reduce post-harvest grain losses caused by insects and pests which are constraints to the wide utilization of the produce.

PRODUCTION OF PUMPKIN BAR

[1]RAYMOND CHINAKA, [2]KUZIVAKWASHE CHASI, [3]VINCENT KAHARI, [4]TAKUDZWA NZOMBE, [5]RATIDZAI BVITIRA, [6]W. GWALA

[1-6]Department of Food Processing Technology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

After taking into consideration that in the Zimbabwean markets most of the snack bars were being imported from other countries this stimulated this project which aims to come up with a pumpkin bar that would increase variety in the market. The production of the bar utilized the locally available vegetable, pumpkin. During the course of the product development, product testing analysis tests were carried out to get the views of the consumers, so that the pumpkin bar would bring about the attributes that consumers liked most. The pumpkin bar was prepared by first peeling the pumpkin and drying the pumpkin to produce the pumpkin powder which was then mixed with other ingredients which include honey , oats, peanuts , milk and milk the flux seed was used as a binder and then moulded into desired shapes. After coming with the product we carried out a sensory evaluation test among the students by use of questionnaires and from the results it showed that 48% of the consumers liked the product while the others were not very fond of the idea of the pumpkin could be cooperated in the production of a bar.

DEVELOPMENT OF COOKIES FROM *COLOCASIA ESCULENTA*

[1]MARK JONATHAN, [2]ELTON M. CHIKOSHA, [3]RUVIMBO CHIHWAI, [4]VANESSA CHAWAFAMBIRA, [5]ELIZABETH V. [6]MUNGWARI,[7] F. MUJURU, [8]C. NYAMBI

[1-8]Department of Food Processing Technology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

After realizing that in the Zimbabwean market the dominating cookies are from wheat and that the *madhumbe* crops are being underutilized, the main aim of this project was therefore to come up

with a product which diversifies products on the market, hence the production of *madhumbe* cookies. During the course of the product development, concept development testing and prototype development analysis tests were carried out to get the views of the consumers, so that the *madhumbe* cookies would bring about the attributes that consumers liked most in wheat cookies. *Madhumbe* were peeled, washed, sliced, dried and milled to obtain flour. The *madhumbe* flour was then blended with wheat flour. Other baking ingredients were then added to attain a non-sticky dough which was cut into shapes then baked. Varying proportions of ingredients and different temperature-time profiles were used during baking while noting the colour, texture and appearance until a desirable product was obtained with the attributes expected by the consumers. Sensory evaluation was carried on the product by use of questionnaires. From the results obtained 68% of the consumers liked the product, 18% did not like the product and 14% neither liked nor disliked the product.

FORMULATION AND DEVELOPMENT OF BREAD FROM BLENDING WHEAT (*TRITICUM SATIVUM*) AND SORGHUM *(SORGHUM BICOLOR*) FLOUR

[1]EDWARD MAKUMIRE, [2]MUNYARADZI MUTERO, [3]EVELYN GUMUNYU, [4]DEPHINE GWEZERE, [5]TARIRO CHIKANGA, [6]RUVIMBO MUKOMBERO, [7]RAPHEAL KWIRI

[1-7]Department of Food Processing Technology, Harare Institute of Technology, Ganges Rd, Belvedere, Box BE 277, Harare

After realizing that sorghum, a small cereal grain produced in Zimbabwe, was being underutilized yet it has high fiber, an idea of making bread from a blend of white sorghum and wheat flour. The aim of the project was to produce a healthy bread, with the objectives of formulating the wheat to sorghum ratio, designing a production process and determining the major nutritional value of the wheaghum bread. The bread was made by blending sorghum and wheat flour, yeast, salt, sugar, baking fat, and water to form a dough. The dough was kneaded and fermented primarily for one hour at 35 degrees Celsius then secondarily for 30 minutes at 35degrees Celsius. The bread was baked at 220 degrees Celsius for 15 minutes then the temperature was reduced to 180 degrees Celsius for 30 minutes to complete the baking process. During the course of the product development, product testing analysis tests were carried out to get the views of the consumers, so that the wheaghum bread would bring about the attributes that consumers liked most in bread. Many samples of the bread were prepared while varying the sorghum contents until complete rising

of the bread dough had been achieved. Temperature was maintained whilst noting the texture, taste, color, springiness and the proximate analysis of the bread until a desirable product was produced with all the expected attributes. After coming up with the product sensory evaluation tests were carried out among the students by use of questionnaires and from the results it showed that 80% of the consumers liked the product while the 10% where not very interested about the idea of the sorghum containing bread and the other 10% rejected the bread.

Pharmaceutical Technology Department

FORMULATION OF AN ANTIFUNGAL CREAM AND POWDER TO ALLEVIATE SYMPTOMS OF DERMATOPHYTIC INFECTIONS USING ACTIVE EXTRACTS OF *SOLANUM INCANUM, PLUMBAGO ZEYLANICA, AND AZADIRACHTA INDICA*

[1]CHITEKA NYASHA, [2]MAGEZA DEON, [3]MHIKE MUNASHE,[4] CHIWARA MEMORY

[1-4]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Skin infections are often considered trivial. However, these infections are in fact frequently intractable and often recur. There is need for medicinal preparations to alleviate the signs and symptoms of dermatophytic infections. This study was aimed at incorporation various plants active extracts from *Solanum incanum, Plumbago zeylanica , Azadirachta indica* to formulate a range of herbal antifungal products. The plant phytochemicals were extracted using methanol, an organic solvent, and then purified using a rotary evaporator. This process removes methanol from the extract which is harmful to the skin. The efficacy of the product was evaluated be determining the minimum inhibitory concentration (MIC) of the extract on various fungi species. The MIC range of the extract was shown to be 0.03-4ug/ml. MIC tests were done on *T. Rubrum, T. Mentagrophytes and E. Floccosum* which are some of the fungi that are responsible for dermatophytic infections.

Key words: *Antifungal, solanum incanum, Plumbago zeylanica, Azadirachta indica*

FORMULATION OF AN ANTI-AGING CREAM INCORPORATING EXTRACTS FROM *ADANSONIA DIGITATA, AZADIRACHTA INDICA, AND ALEO BARBADENIS*

[1]CHABATA TAFARA B, [2]GASSELER RUKUDZO G, [3]MAGORIMBO W, [4]MAUZENI M, [5]MUCHENJE E

[1-5]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

The principal functions of the skin are all affected by structural changes in the skin with ageing. After middle age, most functions are reduced by as much as 50%. Together, genetic and actinic aging target important metabolic pathways in skin cells that trigger the signs of aging such as skin roughness and wrinkling. Because one of the aims of the cosmetic industry is to maintain youthful appearance of the skin, treatment that reverse the signs of aging are significant business opportunity for this industry. In this study an anti-aging cream called Forever Young was formulated using extracts from *Adansonia digitata, Azadirachta indica, and Aleo barbadenis*. The solid liquid extraction method used to extract the phytoconstituents required from the fruit pulp of *Adansonia digitata*. Using a similar method, oil was extracted from *Azadirachta indica* seeds. *Aleo barbadenis* gel was mechanically extracted from fresh aloe leaves. The combined effects of the extracts produced an anti-aging cream with the following characteristics: free radical scavenging, moisturising effect, skin regeneration, collagen synthesis properties, and sun screen properties. A number of efficacy and stability tests such as accelerated stability test, window ledge analysis, freeze thaw and emulsion stability tests were conducted on the preparation. There was no creaming or cracking of the formulation. An anti-aging cream was successfully prepared.

Key words: *actinic aging, ultraviolent radiation, Adansonia digitata, Azadirachta indica, and Aleo barbadenis*

FORMULATION OF A HERBAL TOOTHPASTE AND MOUTHWASH TO PREVENT AND ALLEVIATE THE SYMPTOMS OF DENTAL CARIES AND PERIODONTITIS INCORPORATING EXTRACTS FROM *PILIOSTIGMA THONNINGI* AND *ZANTHOXYLUM CHALEBYUM.*

[1]KUTSEZA ROSE, [2]MLAMBO SIPIWE, [3]MASHOKO DAWN, [4]MAVURA VICTOR,[5] SIMARI MUNASHE

[1-5]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

The use of herbal plants as medicines date back to pre-historic times. The main objectives of this project was to extract antibacterial phytochemicals from *Piliostigma thonningii folium* and *Zanthoxylum chalebyum rhizome* and cortex, to collect and culture the individual oral bacteria causing dental carries and periodontitis , and to formulate a toothpaste and an oral rinse. During the project the phytochemicals from *Piliostigma thonningi* and *Zanthoxylum* chalebyum were successfully extracted. However, the collection and culturing of the individual bacteria was eventually not carried out due the time limitations. Typical toothpaste and mouth rinse formulations contain several components such as a humectant, surfactants, sweetener, preservatives, water and other active ingredients. The formulation of a toothpaste and an oral mouth rinse were successfully achieved in thus study.

Key words: *herbal oral rinse, toothpaste, Piliostigma thonningi and Zanthoxylum chalebyum*.

COSMETIC FORMULATION OF ANTIMICROBIAL, ANTI-FUNGAL, ANTI-INFLAMMATORY AND ANALGESIC HERBAL WASH AND OINTMENT FOR TREATING DIABETIC ULCERS INCORPORATING ASPARAGUS AFRICANUS ROOT, XIMENIA CAFFRA SEED, AZADIRACHTA INDICA LEAF AND BARK EXTRACTS

[1]RUPIYA TINASHE COASTER, [2]MUGUTI MUNASHE VALENTINE, [3]MATONSI RUKUDZO LORRAINE, [4]NGIRANDI WILLIAM TINASHE, [5]MUSIMHI MELEESCENT

[1-5]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Diabetic foot ulcers are extremely debilitating and difficult to treat. Multidisciplinary management, Patient education, blood glucose control, debridement, offloading, infection control and adequate perfusion are the standard of care endorsed by most guidelines. The need to treat ulcers led to the incorporation of various plant active extracts from Asparagus africanus, Ximenia caffra seed, Azadirachta indica leaf and bark extracts to formulate and anti-microbial, anti-inflammatory and analgesic herbal wash and ointment. Extraction of actives from Azadirachta indica back and leaves were obtained using 70% aqueous acetone and n-hexane with yield of 42.8% and 66.7% respectively. From roots of Asparagus africanus n-hexane was used with a yield of 35.7%. The required oils from the Ximenia caffra seeds was extracted using n-hexane with a yield of 85.7%. The MIC test results showed that the combined extract was resistant to P aeruginosa at concentrations between 0.1% and 1% meaning that the extract was unlikely to be effects at low concentrations. At 2%, the combined extract was likely to be effective at this concentration.

Keywords: *Diabetic foot ulcers, ointment, wash, Piliostigma thonningi, Zanthoxylum, Ximenia caffra, chalebyum.*

COSMECUTICAL FORMULATION OF A TOPICAL CREAM AND A SOAP TO ALLEVIATE THE SIGNS AND SYMPTOMS OF ATOPIC DERMATITIS (ECZEMA) USING EXTRACTS FROM *TERMINALIA SERICEA, STERCULIA APPENDICULATA,* AND *ALEO ZEBRINE*

[1]TINASHE MAZOWE, [2]DANAI SITHOLE, [3]SONENI MUMUMBA, [4]GUGULETHU TSHABA, [5]RUVIMBO MUSARIRA

[1-5]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Eczema (atopic dermatitis) is considered to be a minor skin condition albeit one that is accompanied to a lot of discomfort. Eczema has been shown to decrease the quality of life of people with the condition. The use of corticosteroids and antihistamines have been the main forms of treatment for many years. However, these medicines are relatively expensive and long-term use causes significant health problems. The purpose of this study was to prepare a herbal cream and soap used to alleviate

signs and symptoms of eczema. The herbal cream and soap were successfully formulated using extracts from *Terminalia Sericea* which has antimicrobial and wound healing properties. *Sterculia Appendiculata* oil is an emollient and also has anti-inflammatory properties, whereas *Aleo Zebrina* gel has anti-pruritic properties.

Key words: *Eczema, anti-pruritic, anti-inflammatory, anti-microbial, corticosteroids, antihistamines, atopic dermatitis*

COSMECUTICAL DEVELOPMENT OF AN ANTIFUNGAL BATHING GEL AND A DUSTING POWDER USING ACTIVE EXTRACTS OF *ALOE ZEBRINA, CITRUS LIMONUM AND STRYCHNOS SPINOSA*.

[1]TSIMBA PAMELA, [2]SITHOLE MAVIS N, [3]NYAGATO ABIGAIL, [4]MVUNDURA CHENJERAI J

[1-4]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Traditional plants have been used for the management of antifungal infections including *Tinea versicolar.* Plants that have been used include *Strychnos spinosa* bark tinctures as well as Aleo Zebrina gel. The aim of the study was to formulate an antifungal bathing gel and a dusting powder for use in alleviating signs and symptoms of *Tinea versicolar* using active extracts from *Strychnos spinosa*, *Citrus Limonum* and *Aleo Zebrina*.

Strychnos spinosa, Citrus Limonum and *Aleo Zebrina* were collected from a forest in Seke rural area, Rusape, and in Harare respectively. Steam distillation was used to obtain lemon oil. Strychnos spinosa tincture was prepared in 80% alcohol and Aleo gel was extracted using simple hand method. The Minimum Inhibitory concentration test were carried out. Fungospin bath gel and dusting powder were formulated and stability tests were done. The window ledge test and freeze thaw tests were also done. Packaging and labelling of the bath gel and dusting powder was done at Harare Institute of Technology laboratories.

Fifty millilitres of Aleo Zebrina gel, 200ml of Strychnos spinosa bark tincture and 12 ml of *Citrus Limonum* rinds oil were obtained. MIC tests showed significant antifungal activity of the extracts. The bath gel and dusting powder showed to be stable on exposure to sunlight, warming and thawing after freezing.

Key words: *Dusting powder, Bathing gel, Strychnos spinosa, Citrus Limonum and Aleo Zebrina*

COSMECUTICAL FORMULATION DEVELOPMENT OF A TOPICAL CREAM AND PASTE TO ALLEVIATE SYMPTOMS OF GENITAL WARTS INCORPORATING *STRYCHNOS SPINOSA* AND *EUPHOBIA TIRUCALLI* EXTRACTS.

[1]MAGUMISE PETER, DZIMWASHA RODNEY, [3]NYACHEGA CYNTHIA, [4]MATEMA CHIDADISO, [5]TARUVINGA JACQUELINE

[1-5]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Genital warts are an infectious disease caused by human papilloma virus type 6 and 11. It is highly contagious condition that is easily spread through contact. The HPV can be transmitted to neonates during vaginal delivery. If untreated, genital warts reduce fertility as well as obstruction of urinary tract and blocking genital orifices. Active extracts from *strychnos spinosa* were incorporated into the cream and paste. *Strychnos spinosa* is highly cytotoxic alkaloids brucine, strychnine and has been documented to be effective against warts. The milky latex of *euphorbia tirucalli* has also been documented to be effective in the treatment genital warts. As the plants were collected, the alkaloids from *strychnos spinosa* were extracted using the boiling method to remain with a filtrate that was mixed with alcohol for storage and conservation purposes. The euphorbia tirucalli was cut into very small that were immersed inn 80% chloroform, as a way of extracting the milky latex constituents.

Phytochemical screening was done on the extracts by performing chemical tests. The rotary evaporator was used to separate the filtrate from the alcohol and the chloroform. The step by step formulation involved the initial stages of making the water phase, oil phase and finally adding the heat sensitive components of the cream. The extracts were then incorporated into a cream and a paste. The paste was easier to formulate since it had less ingredients as compared to a cream. 100ml of each formulation was prepared.

Post formulation evaluation involved window ledge analysis, freeze thaw test and stability tests were carried out on the preparation. Results showed that the products were stable under various environmental conditions.

Key words: *genital warts, cream, paste strychnos, euphobia tirucalli*

FORMULATION OF ANTI-ACNE CREAM INCORPORATING CARICA PAPAYA AND TRICHILLIA EMETIC SEED OIL EXTRACTS.

[1]ALI-MAULANA MUTODZANISWA, [2]AUXILLIA CHITABWA, [3]CYNTHIA TAPERA, MASELLINE MAGODORO, [4]TANAKA MHLANGA

[1-4]Department of Pharmaceutical Technology, Harare Institute of Technology, Ganges Rd, Box BE 277, Harare

Acne vulgaris is the most common dermatological problem affecting adolescence, women and men. In Zimbabwe, it has proved to be difficult to treat because the current treatments are expensive and are not fully treating the condition. The synergist antibacterial effects of carica papaya and trichillia emetic seed oil extracts were utilised in the study to formulate a cream and scrub incorporating the active extracts from the plants. Seeds were collected and dried. N-hexane was used to extract both Carica papaya and Trichillia emetic seeds oil. Stability tests such as freeze thaw, accelerated stability tests and window ledge analysis were done on the formulations. Both preparations were stable under various environmental conditions.