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# HIT 200 RESEARCH OUTPUT COMPENDIUM



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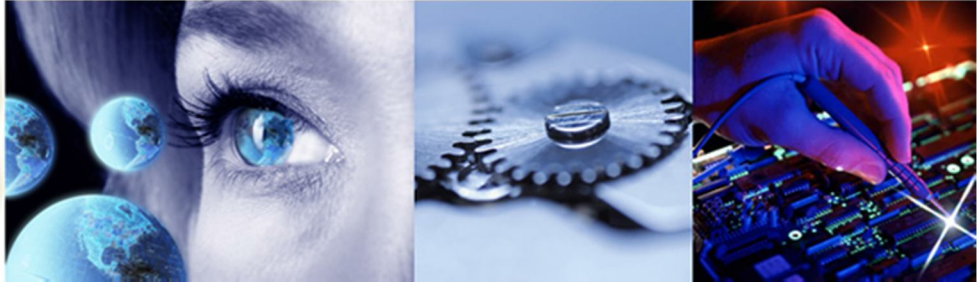
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## HIT 200

Documentation of research projects of HIT 200 done in the academic year 2017-2018 in the School of Industrial Sciences & Technology and School of Engineering

Research  
and  
Development



## **SCHOOL OF ENGINEERING & TECHNOLOGY**

### **DEPARTMENT OF CHEMICAL & PROCESS SYSTEMS ENGINEERING**

#### **A FEASIBILITY STUDY ON THE EFFECT OF SOYA BEAN (GLYCINE MAX) SEED CAKE AS A POTENTIAL NATURAL COAGULANT FOR WATER TREATMENT IN ZIMBABWE**

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This paper presents the treatment of municipality water using soya bean seeds as a Natural coagulant in the water treatment process. The quality of water and its treatment is becoming an increasing concern in developing nations like Zimbabwe, where the quality is poor, proper treatment is lacking. The high cost of treated water makes most people in rural communities to resort to readily available sources which are normally of low quality exposing them to water borne diseases. Safety and health are primary considerations for water purification. Access to save water is a serious issue affecting people of all ages for those living in remote communities and far flung areas where availability of pure water sources is limited; it is a great challenge to impact quality of life in significant ways. This research is carried out to evaluate the effectiveness of powder extracted from matured dried soya beans seeds as an active coagulant in water treatment, which is readily available and commonly recognizable in most urban and rural communities of Zimbabwe. And also Developing countries pay a high cost to import costly chemicals for water treatment such as aluminum sulphate [Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>•14H<sub>2</sub>O]. So in the present study we investigate the natural and combination of Natural +

Synthetic Coagulants of soya beans seeds. Also the experimental results show that it is possible to produce the coagulant of the required efficiency. A total capital investment of \$1 133 473 is required for setting up a plant for the production of the coagulant from soya bean seed cake. Estimated manufacturing costs amounted to \$2 513 674.00. Cost of producing 1 kg of the coagulant is \$0, 46. A kilogram of the coagulant will be sold at \$1, 50, a production rate of 1 096 800 kg every year, a net profit of \$684240 will be realized. The return on investment was calculated and found to be 60, 7% and the payback period was also calculated and found to be 1, 7 years. The company would need to sell 488 666,7kg of the coagulant to break even. The economic analysis shows that it is profitable to produce the coagulant and also the process environmentally friendly. However it is recommended that further studies on operational parameters should be carried out to improve the production rate of the coagulant.

**Keywords:** *Soya beans seed cake (glycine max), Coagulant, Sodium Chloride*

## **FEASIBILITY STUDY FOR THE PRODUCTION OF A POLYMER NANOCOMPOSITE BOTTLE FOR CLEAR BEER PACKAGING.**

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A polymer nanocomposite is a combination of two or more nanomaterial's to produce a material with needed characteristics. This project seeks to manufacture an alternative packaging material to glass for clear beer using recycled polyethylene terephthalate (PET) and nano-zinc oxide in replacement for glass bottles being used in the present day. So far, this technology is not being used in Zimbabwe, but is applied in developed countries such as Japan, China, Germany etc. By making use of sol-gel process to synthesis nano-zinc oxide and our source for PET will be both virgin and recycled plastic water bottles. The two components namely PET and nano-zinc oxide will be melted and blended by a co-rotating twin screw extruder in specific proportions. Thereafter, the polymer nanocomposite will henceforth be moulded and stretched into a bottle by an overall injection mould machine. By materials characterization, end-product is analysed and thereafter the feasibility is determined to be positive, since UV light is absorbed, mechanically stable and the product can be moulded into clear beer bottle. In setting up the plant, for industrial manufacturing of these polymer nanocomposite materials, a minimum and frugal investment of total \$278 656 will be adequate to set up the plant functional and resultantly break-even after 1.6 years, with a return on investment at 63%. This innovation seeks to

set the pace in Zimbabwe for nanotechnology and address issues to do with reduction of land pollution ,trade deficit (as raw material for the current glass package is largely imported), indigenisation, employment creation, entrepreneurship and a wide variety of positive applications and implications. These products are declared safe and therefore fit in the marketing trends for improved product quality and customer preferences.

**Keywords:** *Nanocomposite, Nano-zinc oxide, Sol-gel process, Polyethylene terephthalate*

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## **THE FEASIBILITY STUDY OF GRANULATION OF ANAEROBIC DIGESTATE TO BIOFERTILIZERS**

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Research has shown that liquid digestate when applied to the plants, needs a supplement of chemical fertilizers to increase the NPK content. This project focuses on granulating the digestate to concentrate the nutrients thus increasing the NPK content and reducing the use of chemical fertilizers as a supplement therefore reducing leaching. Anaerobic digestate from pig slurry with 2.01%N, 0.1%P, 0.1%K, 75%water and 22.69%Organic content plus Trace elements (Ca, Mg, Na, Zn, Mn), was granulated into 4mm to 6mm spherical granules using Starch binder containing excellent moisture absorption properties. The granules were analysed and were found containing 8.364%N, 0.416%P, 0.416%K, 3.5%water and 90.804%Organic content plus Trace elements. Mass Balances were carried out and the production of 100000kg/day of the digestate granules was established assuming 8 working hours a day. Energy Balances were carried out and a pump handling a volume of 0.0045m<sup>3</sup>/s requiring a power of 17016.35W per day was determined. An economic analysis of the project shows that a total amount of is needed\$263500 to purchase the project equipment as part of capital injection for a successful project to be conducted. The return on investment was 52% with a production cost of \$0.23/kg and a selling price of \$0.49/kg giving an annual profit 57.3%. The repayment period is estimated at 23 months of operation.

**Keywords:** *Anaerobic digestate, granulation*

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## **FEASIBILITY STUDY ON THE PRODUCTION OF FUEL BRIQUETTES FROM STOCK FEED WASTE**

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A class of models are derived for studying the need for cheaper renewable source of energy in the Zimbabwe. In order to alleviate atmospheric pollution, to conserve energy and to reduce space problems through the utilisation of waste material. It is necessary to spread the practise of densifying waste material which is expired stock feed rather than to leave it and cause some environmental problems. Untreated expired stock feed has low bulk density and high transportation cost. The development of new screw press briquetting for treating expired stock feed will incorporate properties of compressive strength, firing (burning) performance, combustion mechanism, and moisture content. Experiments to measure moisture content, competitive calorific value, burning rate, and briquette stability through drop test were carried out. According to experimental results and analysis showed that a good briquette will be produced at a moisture content of 14%. The burning rate of a compressed briquette is at 0,82g/s and the has a calorific value of 14 895,2Kj/Kg. Experimental results shows the necessity for the development of expired stock feed briquetting technology which will expatiate energy problems in Zimbabwe. However, the utilisation of material regarded as waste will implement for a new renewable cheaper source of energy which will supplement current energy sources in Zimbabwe. The financial gains of this project is hinged on a pricing of \$3.35 per 5 kg packs with a capacity of 450kg per hour, the payback period is 2.1 years. It is environmentally friendly to compress the stock feed waste instead of disposing them since the poor management of the feeds can cause an increase in land pollution as well as shortage of space on the Industrial site. More so, due to high temperature exposure, risks of toxic emissions into the soil are enhanced.

**Key words** *Briquettes, waste, renewable, expired stock feeds, densification*

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## **FEASIBILITY STUDY ON THE PRODUCTION OF FERROUS SULPHATE MONOHYDRATE FROM SCRAP METAL.**

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A lot of scrap metal in Zimbabwe is disposed almost daily and due to lack of value addition methods in the country the current innovative ways of its use involve sculpture making which is almost non-profitable. Hence there is need to utilize the scrap metal in a profitable way. A solution from an environmental and economic standpoint is to use the scrap metal in the production of ferrous sulfate monohydrate. This would also be an initiative to reduce land pollution. The project focused on the feasibility study on the manufacture of ferrous sulfate monohydrate from scrap metal. It focused on research of the best reaction conditions and feasibility analysis in the production of the product in question. Experiments and thorough research was done so as to optimize production. Online journals, questionnaires and experiments were mostly used to collect the data necessary. These were used in order to check if what actually is produced goes hand in hand with what literature tells. The process involved the use of scrap metal (ferrous) to produce ferrous sulfate monohydrate by reacting the iron source and a sulfuric acid solution having a concentration within the range of between about 10-90 percent, separating the resulting solution from the unreacted iron and adding more concentrated sulfuric acid to the solution to bring the free sulfuric acid concentration up, to precipitate pure ferrous sulfate monohydrate then separating the pure ferrous sulfate monohydrate precipitate from the filtrate. The economic analysis for the project showed that it is profitable to produce ferrous sulfate monohydrate large scale from scrap metal (using locally available resources). The process is environmentally friendly. Our project is thus feasible.

**Keywords:** *Ferrous sulfate monohydrate, Scrap metal, sulfuric acid*

## **MASS AND ENERGY BALANCE ON THE EXTRACTION OF GOSSYPOL FROM COTTON SEED CAKE USING ACETONE**

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In this project on the feasibility study of extraction of gossypol from cottonseed cake using acetone a lot of experimental work was done and the most suitable method of extracting more gossypol from cottonseed cake was derived. The main aim was to find if acetone could extract more gossypol amounts that would make the cottonseed cake suitable for animals to consume. Parameters like time duration of cottonseed cake being soaked in the acetone, the ratio of acetone and water solution and temperature of the solvent were varied and the best conditions were derived. For time the duration of cottonseed cake being soaked in acetone water solution was varied from 10 to 30 minutes and the

optimum time was found to be 20 minutes. The acetone to water ratio was varied between the following ratios which were 7:3; 5:2;1:1 and 3:1 and the optimum ratio was found to be 7:3. The optimum temperature was found to be 25 degrees Celsius which is the stand room temperature. This plant produced 9.3 tonnes per year of gossypol that can be applied for use in pharmaceutical industries and 166 tonnes per year of cottonseed cake free of gossypol. In the project we also carried out economic analysis. This analysis was carried out to determine the amount of capital required to set up a pilot plant, the expenses that would be incurred in running the pilot and plant and the profits the pilot plant would generate. In the economic analysis we were able to determine the start-up capital which was \$476 147.9. The Return On Investment was 26.03% and the Payback period time was 3.8 years. The breakeven sales and quantity were \$544 480.70 and 398 840kg respectively. In conclusion we recommend that use of catalyst could be applied to reduce reaction time and energy intergration techniques such as pinch technology can be incorporated to ensure efficient and more economic energy use.

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## **FEASIBILITY STUDIES ON THE USE OF SAWDUST AS A BINDER IN COAL BRIQUETTING.**

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Over the years, energy conservation is an issue that has received a great deal of public attention. With the growth in population and subsequent additional demand in energy, it has become apparent that innovative methods are needed to create supplementary sources of energy. As it is briquettes have been produced in order to supplement energy. Coal briquettes have been produced using different types of binders. This project aims to produce coal briquettes where hydrolysed sawdust is used as a binder. Sawdust contains lignocellulose which is adhesive. Experiments were carried out to find the extent of hydrolysis which is suitable. Hydrolysis was carried out at 120°C. Tests were also performed to see which is most effective to use between the hydrolysed sawdust and unhydrolysed sawdust. A moisture content of 0.08% and a binder content of 15% were found to be appropriate. An economic assessment was done on the project. A payback period of 1.5 years and rate of return of 66.7%. This work will reduce the amount of sawdust from wood a processing industry that is being discarded as waste. It will also reduce the amounts of coal fines at Hwange Colliery which is also regarded as waste and at the same time supplement energy.

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## **FEASIBILITY STUDY ON THE PRODUCTION OF ACTIVATED GROUNDNUT SHELL FOR THE REMOVAL OF LEAD (II) AND CHROMIUM (III) IONS FROM INDUSTRIAL WASTEWATER.**

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The bio-adsorbent, activated groundnut shell was prepared from groundnut shells, a ligno-cellulosic waste from agro-industry, for the removal of heavy metals, Lead (II) and Chromium (III), as a function of pH and metal concentrations in single solutions. The activated groundnut shell was characterized using the iodine test which indicated an approximation of the pore size of the activated groundnut shell. Different experimental approaches were applied to show the effectiveness of the activated groundnut shell in the adsorption of  $Pb^{2+}$  and  $Cr^{3+}$  ions from industrial waste water. The ultimate maximum adsorption capacity obtained from the Langmuir isotherm observed in mg/L were 73.76 and 80.5 for Lead and Chromium respectively. The adsorption capacity of the activated groundnut shell is comparable to or greater than that of other reported adsorbents. The groundnut shell contains certain organic compounds which can be comprehensively developed and utilized, not only can develop a new kind of resource, but also can reduce environmental pollution of the waste, so the research and development of activated groundnut shell has a huge economic benefit. From an economic analysis, the return on investment, which is used to evaluate the efficiency of an investment was found to be 40.99%. The payback period was also found to be 2.4 years.

**Key words:** *Bio-adsorbent, Heavy metals, Groundnut shell, activated carbon, isotherm, ligno-cellulosic*

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## DEPARTMENT OF INDUSTRIAL & MANUFACTURING ENGINEERING

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### DEVELOPMENT OF A HYBRID LIGHTING AND CHARGING SYSTEM

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The purpose of this research was to develop a lighting and charging system that uses alternative energy powering sources. Currently Zimbabwe has a big problem of shortage of electricity especially in rural areas where the case is either shortage or total lack of electricity. This product is mainly to give the citizens of this nation another energy source, environmentally friendly and readily available, to provide a lighting system and recharge their small devices. The project also comes as a solution to one of the United Nations Sustainable development goals, which supports widespread provision of electricity to remote areas. The research methods applied in this project were the use of electronic articles and journals which have been written in the field of energy and other aspects of the research; field research will also be done in order to get information on people's preferences in terms of wearable devices; conceptual designs of the device; modelling of prototype as well as circuit design. The researchers came up with a design that utilizes solar-kinetic technology. The design answers the need for a readily available and environmental friendly light and power source. The target market for the design is people deployed for outreach work in remote areas where there is shortage of electricity basically for lighting and charging purposes.

**Key words:** *Alternative energy, Environmentally friendly, Lighting, Solar kinetic technology*

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## **DESIGN OF A TRACTOR DRAWN ONION HARVESTER**

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The purpose of the project is to produce a mechanism that harvests onions from the ground at a faster and less costly manner. The harvesting of onions is done manually and is therefore time-consuming and expensive since local farmers employ a large number of people to work for them during the harvesting season. This is because cultivation of onions is characterized by a low level of mechanization, where local farmers do not use any type of machinery except for the ordinary garden tools. Research methods used were interviews to obtain soil crop data from local farmers (for onions and other leguminous vegetables) and electronic journals. The developed design was a tractor drawn onion harvester to lift the lodged crop, dig the bulbs, lifting the bulbs and separating of soil, and windrowing the crops for later collection of bulbs from the field. The design is recommended for use by Zimbabwean onion farmers.

**Key words:** *Mechanization, Leguminous vegetables, Onion cultivation*

## **DESIGN OF AN ELECTRONIC ASSET SECURITY SYSTEM**

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The purpose of this research was to design an electronic security system for a local university. Laptops have become a target of choice for thieves all over the country because they are small, valuable, can be moved quickly, are easily hidden and there is a market for them. Currently at a local institution security checks for laptops are causing long waiting queues resulting in asset security loopholes. Cases of identity theft were an individual impersonates as the real owner of the laptop, is a cause for concern and a major loophole in the current system. This research seeks to generate laptop specific barcodes and to design a database containing students' information such as registration number, profile picture and departments where the security personnel matches the face of the holder

with the one in the database. Observations, interviews and internet site visits were used during the research. The result was a system that the security personnel used to verify ownership as well as reduce waiting times for both the security personnel on duty and the students. The design is recommended for application for university security systems in Zimbabwe.

**Keywords:** *Electronic security, Asset security, Barcode*

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## **DESIGN OF A COMPOSITE PAVER-PASTE MAKING MACHINE**

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The purpose of this research was to develop a composite paver paste making machine for use in paving for households and outside office areas. Unsafe disposal of plastic material in the environment has resulted in excessive land pollution in the city centers therefore the researchers designed a machine, which mixes sand and plastic to produce paste, used to make paving bricks. The project was designed in order to optimize the existing plastic sand mixing process, which was being conducted manually and utilize plastics, which are being disposed in the streets by the populous and put the plastics to good use at the same time helping reduce pollution. The research methods incorporated were a case study of the project, observations of how the process is carried out by existing brick makers in order to identify the problems they face to improve on that problem, journals for more in depth information of the design and requirements. The researchers used Computer aided software to produce the working drawings of the prototype. The researchers produced a fully functional prototype that was able to produce a strong high quality brick which is environmentally friendly. The design is recommended for use by paving companies in Zimbabwe.

**Keywords:** *Plastic disposal, Pollution, Environmentally friendly*

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## **DESIGN OF A LITTER PICKING MACHINE**

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The purpose of this project was to design a litter picking machine. The Harare City Council has been employing cleaners who use manual means to pick up litter and they have three mechanical sweepers. Manual means have proven to be time consuming and leave the workers susceptible to musculo-skeletal diseases (MSDs) and fatigue and the mechanical sweepers which are being used are not able to clean pavements and alleys in the Town Centre. The City Council has not been able to reduce the rate of land pollution in the Town Centre although bins have been installed in every street but the people continue to dispose litter everywhere. Street urchins are also to blame for litter, as the streets are their home and they throw rubbish around and empty bins. In addition, pedestrians are to blame for littering the CBD, their contribution is mainly via empty food packaging. Hence land pollution is still increasing at an alarming rate due to the inappropriate attitude of people towards litter. The researchers utilized field observations, articles and journals as tools for obtaining information during the research. The design developed used the mechanism of a vacuum cleaner to pick the litter. The design is recommended for use in aiding the city council workers in reducing land pollution in the Harare Town Centre.

**Keywords:** *Litter picking; Land pollution; City council workers; Musculo-skeletal diseases*

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## **DEVELOPMENT OF A GOLD ORE SEPARATOR**

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The purpose of this project was to design and develop a gold ore separator for small scale mining. The use of the centrifugal gold separator has assisted many gold processors in separating gold from the ore, though shortcomings come, as a considerable amount of gold is also washed together with the other less dense residual material. Moreover, the process has a low time productivity. The research methods used included collection of information using quantitative research involving various research tools, analysis of the collected information, design of the prototype and actual development using various CAD software. The developed design was an integrated separator system, which is expected to increase the amount of gold obtained from the ore separation process by at least 5%. The design is recommended for adoption by most large and small-scale gold producers in Zimbabwe.

**Keywords:** *Small scale mining, Gold processor, Integrated separator system*

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## **DEPARTMENT OF POLYMER TECHNOLOGY & ENGINEERING**

### **DEVELOPMENT OF A COMPOSITE OF PMMA AND KERATIN FROM CHICKEN FEATHERS FOR MAKING ROOF CEILINGS**

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There about 8 050tonnes of chicken feathers which are disposed into the environment by way of burning or burying underground posing as a pollution threat to the water and soil environment. Chicken feathers are waste products of poultry industry with approximately 91% being keratin, 1% lipids and 8% water. The amino acids making the feathers tend to cross-link with one another making tough, lightweight fibres with good thermal and acoustic properties. This polymeric nature of the feathers was utilised in this research to make a biopolymer that could be used for the making of ceilings. The biopolymer was extracted and tested for chemical and thermal stability and was found to be useful as ceiling board making material. Compression and tensile strengths of the biopolymers were tested and were of high strength values.

**Keywords:** *Feathers, biopolymers, keratin, ceiling boards.*

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## **SYNTHESIS OF STYROFOAM ACTIVATED CARBON FILTER**

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In this study activated carbon was prepared from waste Styrofoam using chemical activation method in which phosphoric acid and potassium hydroxide were used as impregnating agents that is suitable for cost effective use in the removal of chloride in water. The properties of the activated carbon were evaluated based on the activation temperature, concentration of potassium hydroxide and phosphoric acid, uv-vis characterization, phenol adsorption and iodine adsorption number. Three formulations were made using 85%, 60% H<sub>3</sub>PO<sub>4</sub> and 1.8M KOH as impregnating agents for activation using ratio 1:1 and 1:2 of impregnated agents to polystyrene. The effects of process variables such as activation time and temperature were evaluated. The phenol adsorption results for the different activated carbons corresponded well to adsorption.

**Keywords:** *Styrofoam, activated carbon, iodine number, impregnating agent*

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## **SYNTHESIS AND EVALUATION OF ROADMARKING ENHANCED PHOTOLUMINOUS POLYMER-BASED PAINT**

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This study focuses on trying to tie down the number of road accidents. In 2016 38620 were reported in which 1720 people died and 11379 sustained permanent disabilities. This research project focuses on formulating a durable, visible, phosphorescent road marking paint to replace the reflective paint which is currently being used. The formulation was done by adding the pigment to the polyol using an electric hand continuously agitating the mixture until a uniform distribution of the pigment particles. Additives such as strontium aluminate and polystyrene followed by a curing agent to form a single component based paint. The product of this research when applied on the actual field conditions can work better than the currently used road markings.

**Keywords:** *paint, phosphorescent, reflective, polyol*

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## DEPARTMENT OF ELECTRONICS ENGINEERING

### SOLAR POWERED TRAFFIC LIGHTS

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Traffic control signals have been used in directing flow of traffic since inception in the late 1800s with the technology based on fixed time. With the increased traffic at particular times of the day, the existing fixed delay traffic control system is proving to be inefficient and ineffective in maintaining a smooth flow of traffic. The timers are programmed to function in a specific manner irrespective of the traffic at a given time of the day and inevitably, fail to avoid congestion. The period in focus being high traffic density times “peak hours” when there is unequal number of vehicles on intersecting roads of which the current system does not give more priority for higher vehicle density lanes. Thus, the need to design and implement a solar powered microcontroller-based traffic light system that has varying time modes for high and low density lanes, based on real-time for road intersection control. The project is implemented using a PIC18F452 microcontroller to control the traffic lights circuit, due to its ADC pins that enable flexibility in interfacing an external DS1307 clock. The DS1307 chip is a serial real time clocking device that is interfaced to the PIC18F452 for accurate time signal, which is displayed on an interfaced LCD. The system changes delay times displayed on the 7-Segment for motorists when RED, YELLOW or GREEN on the intersecting lanes, based on the real time clock signal from the DS1307 to toggle change in delay times on periods when traffic density is high. The functioning of the system and processes is by an Assembly Language Program loaded into the microcontroller.

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### BABY MILK WARMER

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The era of civilization has brought gender equity and women empowerment in many countries and societies leading to more women schooling or working thereby not having enough time to breastfeed their babies. Since breastfeeding babies are not allowed at work or school, mothers have resorted to breast pumping milk and leave the baby being attended to by some maids. Milk should be stored at a cold temperature to prevent spoilage and served at an elevated temperature of 35 °C. Several projects such as Advent by Philips have been done to design warming equipment for baby milk and formula to substitute the current methods of warming with hot water and hot plate which is slow, inaccurate and not precise. There is need to design a microcontroller based portable battery powered baby milk warmer which is portable, affordable and which can warm baby milk or formula to 35°C in short time . The proposed project will consist of heating element, water is added prior to immersing a bottle containing milk and the warmer is then switched on manually. The programming language used is assembly-programming language. A buzzer rings when a threshold of 35°C is reached .The temperature will be displayed on the LCD continuously. The LM35 sensor sense temperature of water and sends an analogue voltage signal to the PIC16F877A microcontroller .The LM35 is connected to the ADC module of the PIC16F877A microcontroller. The buzzer, TRIAC and the LCD are connected to the output ports of the microcontroller. The microcontroller will decode input signal from LM35, sends output signal to LCD to display temperature value and make decision to activate TRIAC if 35°C is reached.

## **FPGA BASED MULTIUSER VENDING MACHINE**

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At the Harare Institute of Technology long queues were being formed due to limited access to the purchase of meals tickets therefore, the FPGA based multiuser vending machine was designed to operate 24 hours a day, selling three types of tickets, namely for beans, beef and chicken to two separate individuals on two platforms controlled by one FPGA. The system was programmed in VHDL language and implemented on an FPGA Altera DE2 board hence the name FPGA based Multi-user Vending machine. The form of payment makes use of the school ID card, which is represented by three toggle switches, each combination representing a different payment price. This was done for security reasons since the vending machine will not be monitored. Other vending machines used RFIDs as the form of payment to reduce the risk of the machine being damaged by thieves attempting to steal the money in the machine. RFID operated vending machines reduce complexity of the system by removing levers and gears that would function to receive credit or give change to the user. The



vendee uses a keypad to choose the ticket of choice on the options displayed and the system then requests for payment on the display and the vendee pays by toggling a toggle switch corresponding to the price of their ticket option. The machine requests for the pin and after the user inserts the pin through the keypad the requested ticket is printed. The vending machine was also made available for individuals that do not understand the native languages (Shona and Ndebele). The system was designed using the FPGA as the processor because of its capability to accomplish parallel processing hence multiple user abilities and its flexibility when upgrading the system. The VHDL code controls the keypad, LCD, 7 Segment display and serial communication. Serial communication between the FPGA and PC is achieved via a USB to serial cable. In the PC a C# program, designed using Microsoft Visual Studio would establish communication between the PC and the printer. A signal is sent from the FPGA in ASCII format and the C# program would print the corresponding ticket to the received ASCII signal. An LPB6020 Canon printer was used for printing. The system had one major drawback, that is, after sending a signal from the FPGA the PC ports had to be re-opened manually. Improvements to the systems would be to add code to the C# application that will allow automatic reopening of PC ports and to add a database for the vending machine using NIOS softcore processor to keep customer details.

## **DESIGN AND IMPLEMENTATION OF FPGA TRAINER BOARD EXTENSION CIRCUITS**

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This document presents the design of FPGA based trainer board extension circuits modelling specific applications. The applications modeled are traffic lights, horizontal actuator and logic gates operations. The traffic lights, were modelled using LEDs mounted on a small PCB. The horizontal actuator was implemented using a motor control connected to a rail that is capable of transporting people together with their goods. Switches were used so as to specify the desired destination for individuals using this actuator. In addition, the digital logic gates were modelled using LEDs mounted on their own PCB. The status of the inputs and outputs are indicated by these LEDs which will be either on or off for a logic zero or a logic one respectively. All of the three extension circuits were interfaced to the FPGA and thus VHDL programming language is to be used. The signals from the FPGA are transmitted to these circuits using some bus connectors. This will help the students build working design prototypes which are normally required in thesis and other related subjects. This project will be specifically for VHDL programming language. The trainer board would be used by students for testing their laboratory practical programs. The results should show that the trainer board would help the students in learning how to program and interface FPGA's. Furthermore, these results

on the self-assessment of the students should show that they will be confident enough in applying the knowledge that they have learned from the laboratory experiments using VHDL and the trainer board. From the research, a dedicated course in FPGAs would help students learn programming and interface FPGAs.

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## **CUSTOMIZABLE SCROLLING LED DISPLAY BOARD**

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Scrolling LED Matrix provide flexibility to display graphics, videos, texts and animation and thus they have been adopted worldwide to display information. LED Matrix displays are currently being used in advertisements (billboards), displaying prices on filling stations and destination signs in public transport vehicles. The project is a design of a customizable scrolling led display board controlled by a PIC16F877A. In this proposed project a PIC16F877A based customizable scrolling led display capable of displaying 5 characters is designed. The system comprises of an 8-bit UDN2981A which has a maximum sourcing current of 500mA enough to power an 5x40 led matrix and 8bit serial-in parallel/serial out 74HC595 used to shift data from the microcontroller to turn on and off the led matrix display. An RS232 protocol will be used to interface the proposed system and the PC. Assembly language program will be used as the software interface because it is closer to the machine language thus it serves time for the microcontroller to compile and run the code. The user inputs a text through an interface developed in C# programming language and the input data is sent to the microcontroller and eventually displayed on the led matrix. The characters on the led matrix scroll from left to right.

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## **AUTOMATED CHICKEN COOP**

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The climate in which chickens are bred is a crucial factor to their welfare as well as growth. We have given a brief background of attempts that have been made to monitor and control the chicken house

environment. Challenges and shortcomings associated with these projects have been highlighted and so in this light, proposed in this document is an offline system that is microcontroller based and monitors the environment of the chicken barn for healthy and uniform growth of the chickens. The methodology to achieve this uses sensor to detect the conditions in the atmosphere. The HIH 4030 humidity sensor will assist in the monitoring of humidity by displaying the relative humidity on an LCD. An LM35 temperature sensor will monitor the temperature in the coop whilst the system goes on to control it through an extractor fan and a heater interfaced with the PIC16F877A microcontroller. Also, the availability of water in the chicken coop is monitored through the use of float switches that are also interfaced with the microcontroller and inserted in a reservoir tank that has water being pumped into it based on the state of these switches so that water never runs out. We have also given a table of our expected result, proposed budget and how we are most likely going to progress in a Gantt Chart. This system is cost effective and has been made to best suit the climate and setting in Zimbabwe.

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## **CAR PARKING SYSTEM**

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Due to an increase in motor vehicles in Africa, Zimbabwe is suffering problems of few parking areas against number of vehicles to be accommodated on those few parking spaces. Research shows it is of best interest to design an efficient parking system that directs the driver to the nearest free slot in the crowded parking bay. However, since there is need for eliminating human interference in the above stated situation this delegation designed an H-bridge which is used to control motors which facilitate boom gate opening and closing automatically. The group has opted for designing it since it will be much cheaper and helps in giving us exposure. An assembly program controls the interfaced LCD, motors and parking slot sensors to the microcontroller. The PIC 16F877A is acting as the heart of the system. Research on similar works, which were once done in line with our project showed that indeed there was need for a more convenient way since some of them relied much on internet connectivity, which will not be feasible particularly in a country like Zimbabwe where everyone is not yet well versed with the use of such technologies. Unavailability of some components locally at a lower cost like radio modules limited us to follow the same path our predecessors used in their projects. Our solution is considering the issue of cost in a hard economy like the country is in and also assessing the kind of people focused to benefit from the project. The project is not using any internet connection to counter for problem faced in technical problems like power cuts. The project uses LCD to display number of free slots if any and automatic opening and closure of boom gate upon vehicle

detection. Great caution should be taken when using the system as motor malfunction might be detrimental.

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## **WATER LEVEL MONITORING AND CONTROL SYSTEM**

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Reservoir liquid level monitoring is one of the solution to the quest to save liquid resources, electricity, prevent tank spillages (overflow) and prevent the pump from running dry. The system will help eliminate the financial cost and inefficiency of human interference experienced due to manual controlling of the pump, while capitalizing on the performance and life span of the electric water pump. The system detects and indicates proportional liquid levels and display on an array of LEDs. An assembly language algorithm computes usage rate and time left to empty the water in the tank. In auto mode the system should automatically enable the reservoir tank pump when water level drops below the designated minimum level and disable the pump when the water level reaches the maximum designated level, however the user can manually override the system if there is need to refill the tank before the water reaches the critical level. Non-contact liquid level detection will be employed with the use of an ultrasonic sensor (HC-SR04). The ultrasonic sensor is connected to a microcontroller as an input signal. The microcontroller then reads the height of the water and computes the depth of the tank which will be related to the liquid level which is displayed on the LEDs and the LCD. Ultrasonic sensors use the principle of sound velocity, measuring the time taken from transmission to receipt of a reflected sound wave of frequency above 20KHz when it encounters an obstacle. This time taken is used to compute the displacement between the obstacle (surface of water) and the transducer.

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## **GSM BASED HOME AUTOMATION SYSTEM**

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With advancement in technology things are becoming simpler and easier for us. Automatic systems are now being preferred over manual systems. The purpose of this project is to design and construct a GSM based home automation system. Using GSM network, in this project a home power control system has been implemented that will act as an embedded system which can monitor and control appliances and other devices locally using built-in input and output peripherals. This project works on the potential of 'Full Home Control', which is the aim of the Home Automation Systems. This is an analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as door, gate, geyser and loan watering system via Short Message Service (SMS). The project focuses on functionality of the GSM protocol, which allows the user to control the target system away from place of resident using the frequency bandwidths. The concept of serial communication and AT-commands has been applied towards development of the smart GSM-based home automation system. Home owners will be able to monitor the status of any home appliances under control whether switched on or off remotely from their mobile phones. PIC16F877 microcontroller with the integration of GSM provides the smart automated house system with the desired baud rate of 9600 bps.

## **SINGLE PHASING DETECTION AND APPLIANCE PROTECTION SYSTEM**

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Due to lightning, electricity poles falling, there have been lots of cases where power lines break causing damage to appliances. There are appliances that require three phase power to operate, such as three phase motors. Phase failure or loss of phase causes the remaining phases to draw more current compared to the rated hence over heating leading to winding failure. Winding or motor failure results in frequent motor rewinding which reduces the efficiency of the motor.

There is therefore a need to continuously monitor the three phases to prevent damage and loss of property. Phase loss in a three-phase system should be detected in about 10 minutes, and preventative measures taken. This project seeks to bring up a system which detects single phasing, rings a buzzer to alert of the problem and automatically cut off power supplied to all appliances that use three phases to prevent them from failing. We propose to design a system that is interfaced to the PIC16F877A microcontroller through a software protocol developed using assembly language. The

system would have three single phase transformers connected to the three phases. These transformers step current down to 20A which the ACS 712 current sensors can handle. These sensors send signals of the current flow in the phases to the microcontroller. The microcontroller then triggers the power cutting relays and the buzzer, when there is phase loss. The system is applicable in industries where three phase motors and other three phase appliances are used.

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## **KEYPAD BASED ACCESS CONTROL SYSTEM**

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A keypad based control access system is system which grants access only to authorized users and is employed to a protected area where none but people with authenticated credentials can enter. The implemented system comprises of magnetic door lock which is unlockable and lockable in real time to ensure secured access specifying activation, authentication, and validation of users prior to entering a correct pin code on the keypad. The entire system is associated with a database to ensure and maintain the overall system integrity. The associated database also generates a log report to maintain check – in status of authorized individuals with the primary credentials of each.

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## **AUTOMATED DRIP IRRIGATION SYSTEM**

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This document seeks to present an Automated Drip irrigation system project. Though, by using drip irrigation, the amount of water loss is low compared to other irrigation systems, there is still a significant amount of water wasted. Humans forget, make mistakes and have other things to do other than manually operating irrigation systems. Without close monitoring and control, there are chances that the plants may face stunted growth and/or they may wither because of excessive irrigation or

inadequate amount of water. This shows the need for a Microcontroller based drip irrigation system, which timeously gives feedback control system for monitoring and controlling all the activities of drip irrigation system more efficiently. By automating the system using cheap sensors such as moisture sensors, and water level sensors, the sensors are able to control valves to turn ON and OFF. This allows the farmer to apply the right amount of water at the right time, regardless of the availability of the labour to turn valves ON and OFF thus improving crop performances and help in saving time and water. Our methodology has covered experiments to discover the output values of our sensors under different moisture conditions. Appropriate preset values for the crops were found through research by the Texas A&M University and a combination of conversion calculations. The device developed was able to achieve two out three of the objectives with the last objective failing as a result of a power supply that did not open a solenoid valve. Proof of concept was found and the system is feasible and would definitely bring good yields and potentially improve the agricultural sector of Zimbabwe.





## SCHOOL OF INDUSTRIAL SCIENCES & TECHNOLOGY

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### DEPARTMENT OF FOOD PROCESSING TECHNOLOGY

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#### PRODUCTION OF VEGETARIAN SAUSAGES FROM BOTTLE GOURD SEEDS

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The main objective of this project was to produce vegetarian sausages from bottle gourd (*Lagenaria Siceraria*) seeds. The seeds have been widely consumed in Zimbabwe, but locally, there is no data on the value addition of bottle gourd seeds, hence this study serves to deliver detailed information. The target market for the bottle gourd seed sausage is the vegetarian community and the health conscious individuals. *L. siceraria* seeds were obtained from the communal farmers in Mbare Msika. The seeds were roasted at 160°C for 30-50 mins depending on the moisture content, ground using a motor and pestle or blender, sieved using the mesh number 16 (1.190mm) to remove coarse and unground seed granules together with the chuff. 75g of the bottle gourd seed flour produced was blend with other dry ingredients ns soy oil to produce thing dough. The dough was then put in a piping bag and was piped into pre-soaked cellulose casing to increase its palatability. The sausages were packed in a tray and box as it reduces contamination of the food product. The nutritional value of the sausage were determined. The Kjeldahl procedure was done to determine the crude protein in the sausages and it was found to be 48%. Total carbohydrate was calculated by subtracting the sums of the weights of crude protein, total fat. Moisture and ash in a serving from the total weight of the food in a serving and was found to be 9.99g. Fat analysis was done using the solvent extraction, Soxhlet method and the fat content was 13.5%. Microbial tests were carried out to determine if the sausages were safe for consumption and the results were found to be within normal range of 25 – 250 plate count thus the vegetarian was concluded to be safe. Accelerated shelf life testing was carried out and change in colour due to oxidative rancidity was observed.

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## **BAOBAB CREAM LIQUEUR PRODUCTION**

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The aim of the experiment was to produce a cream liqueur-containing baobab. The term 'cream based' includes a variety of dairy products broadly, including low-fat, milk, cream, half and half, and heavy cream. Production of baobab cream liquor will add to the underutilised baobab fruit. The fruit pulp also has strengths in nutritional value. With a potential to generate income and health benefits. Baobab cream liqueur was produced from fermented baobab fruit pulp. The alcohol produced was blended with cream and other ingredients. The product is a luxurious liqueur which sweet thus can be served in any number of cocktails or after diner drinks, can be served on its own over ice topping for ice cream and other imaginative desserts. The pH of the baobab cream liqueur was analysed using a standard pH meter and the pH of the liqueur was 6.60. The viscosity of the liqueur was found to be 6.87mPas. Being the major nutritional component, Vitamin of the baobab fruit was determined and found to contain high amounts of the which was not affected mainly by the fermentation process. The alcohol content was calculated and was found to be 15.23% According to the Annex 11 of the regulation 110/2008 a cream liqueur should contain at least 10%v/v fat content and alcohol ranging from 15 - 17-v/v hence the liqueur attained the main attributes that are required. Other parameters such as viscosity and pH may vary depending on the manufacturer. Sensory tests were done on colour, flavour, taste, consistency, and overall acceptability to assess the acceptability of the liqueur to the target market, microbial tests were done to assess the shelf life of the product.

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## **PRODUCTION OF INSTANT PORRIDGE MEAL FROM PEANUTS, SOY BEANS, SWEET POTATOES, AND FINGER MILLET**

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Fortified blended foods (FBFs), which are the mixture of cereals and legumes fortified with micronutrients, have been widely used as supplementary food for vulnerable population such as infants and young children in developing countries around the world. The evaluation of current FBFs showed limited evidence on their effectiveness in treating childhood malnutrition resulting in several recommendations on processing and formulation changes to improve their quality and ability to meet nutritional needs. After realising that the existing supplementary food such as the Corn Soya blend only contain plant proteins that had limiting amino acids, there was need to complement with a novel protein. Nutrino is a high protein-energy instant porridge that will complement the existing supplements. During the course of the product development, product testing analysis test were carried out to get the views of the consumers, so that the porridge meal would bring about the attributes that consumers like most. Flour prepared from finger millet, sweet potatoes, soy beans, peanuts, mopane worms and bananas was weighed and mixed. Extrusion cooking was done at 130°C for 30 minutes. The porridges paste was dried in a forced draft oven at 63°C for 12 hours and was milled into flour using a blender, many samples of the instant porridge were prepared while varying the proportions of the ingredients as well as temperature and concurrently conducting sensory evaluation. The product was improved was time until desirable sensory properties and proximate composition of 7.78% (moisture content), 21.96% (protein), 3.45% (ash content), 11.94% (fat), 3.47% fibre, 50.65% (carbohydrate) were obtained. It can be concluded that flour prepared from finger millet, sweet potatoes, soy beans, peanuts, mopane worms and bananas can be mixed in the ration 2:1:1:4:1:3 to produce high energy food 21.96% protein and 30% energy which is in line with WFP recommendations for the FBF. The microbial load of the product is  $3.4 \times 10^4$  CFU which is within the limits ( $<10^7$  cfu) for instant cereals.

## **PRODUCTION OF POWERMAX ENERGY BAR**

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This project is an attempt to increase utilisation of the underutilised finger millet to produce gluten free energy bars for health conscious individuals and to increase varieties in the Zimbabwean market whilst also seeking potential substitutes for wheat. The main aim of the project was to formulate the stages to be followed in order to create a satisfactory product that closely resembles wheat energy bars yet gluten free. The objective of the project was to produce energy bars made mainly from finger millet malt flour and banana flour whilst also backing the expansion of energy bar brands in the food industry. The pre-eminent method of producing energy bars was determined following steps outlined by the proposed methodology. The research was ultimately a means to the utilisation of the finger millet on a commercial basis besides the commercial production of opaque beer. The data collected

was both primary and secondary. The primary data was that of brainstorming, questionnaires, and experiments. Analysis was presented using graphs, pie charts and tables.

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## **DEVELOPMENT OF TEXTURED VEGETABLE PROTEIN FROM SUGAR BEANS BLENDED WITH COWPEAS AND ROUND NUTS**

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Aim of the project was to develop a blended textured vegetable protein from sugar beans, cowpeas and round nuts. The existing TVPs are produced from soya beans, chickpea and cottonseeds consumed as a meat substitute by mostly the vegetarians. Cow peas, sugar beans and round nuts, the traditional vegetables are indigenous crops grown and locally thriving even in drought prone regions. The legumes are rich in proteins, carbohydrates, B-vitamins, retinol, carotene, vitamin E and a variety of essential mineral elements. The development of the blended legumes will help in value addition of the indigenous legumes and to provide a TVP with a new flavour form legumes. Vegetable proteins in general rate low on the PER scale because they frequently lack one or more essential amino acids. Blends of different vegetable proteins can result in higher PER values. The nutritional content of cow peas is 26.44% protein, 27.3%carbohydrates and 29.2% fibre and that of sugar beans is 32% protein and 13% carbohydrates and for the round nuts are 65% carbohydrates and 18% proteins. 25kg, 15kg, 10kg of sugar beans, cowpeas, round nuts respectively were cleaned and sorted then ground into a course powder by the hammer mill. The blended course powder was extruded at 132 degrees Celsius at a feed rate of 50 revolutions per minute and the hot and wet TVPs produced were solar dried. After drying and moisture analysis they were packaged. Three trials were carried out were the first two the legumes were extruded without grinding and the product was course, the last trial was carried out after grinding of the legumes and the product had the desired texture with no course areas. The characteristics of the TVP in terms of colour, texture and taste were desired as of the textured vegetable protein. The protein content calculated by the Kjeldahl method was 24.5% thereby can be a meat substitute in meals. According to the CODEX Committee vegetable proteins have functional purposes as meat replacers or as an optional ingredient.

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## DEPARTMENT OF BIOTECHNOLOGY

### **FERMENTATION OF MOLASSES ENHANCED BY POTATO AND ORANGE PEELS TO PRODUCE ETHANOL USING SACCHAROMYCES CEREVISIAE**

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This investigation was carried out in order to see if the production of ethanol from fermentation of molasses by *Saccharomyces Cerevisiae* can be enhanced by the use of alternative carbon source substrates, that is orange peels and potato peels. The aim of the study was to produce ethanol from a combination of molasses, orange peels and potato peels. The objectives were to determine if potato and orange peels can enhance molasses and increase ethanol yield and to determine the effect of adding urea on ethanol production. To achieve this, different fermentation practicals were carried out as follows, molasses only, potato peels only, orange peels only, orange peels + potato peels, molasses + potato peels, molasses + orange peels, potato + orange peels + molasses. The fermentation results indicated that molasses + potato peels fermentation produced more ethanol. The fermentation with the best result had urea added to it in another practical so as to check the effect of urea. It indicated that urea enhances ethanol production. The average volumes of ethanol produced from fermentation of 250ml of the substrates were 70ml alcohol. At the highest concentrations, the alcohol concentration was around 3ml in every 10ml sample.

**Keywords:** *molasses, ethanolic/ alcoholic fermentation, Saccharomyces cerevisiae*

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### **DEVELOPMENT OF MORINGA-BASED BROILER FEED**

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The present study aimed to develop a *Moringa oleifera*-based poultry feed for broilers through investigating the effects of the different concentrations of moringa in the formulated feeds on broilers.

A total of 50 one-day old broiler chicks was used for this study and randomly divided into four samples, each group having at least 12 birds. Crushed leaves of *Moringa oleifera* were collected from the same farmer from the same tree in order to avoid variations in soil micronutrient content. The other materials (soya and maize crush) used to formulate were acquired from respective farmers in order to avoid variations in the soil micro- and macronutrients as well. The four batches were randomly named Batch 1 (Control for the experiment), 2, 3 and 4 were fed with a conventional feed from National foods and feeds formulated with 5%, 10% and 15% Moringa respectively. Each batch was fed with 50kgs of the given respective feed for 6 weeks in starter, grower and finisher phases. The feed and water were provided ad libitum. After every week, the each bird was weighed and a bird from each batch and these weights recorded was randomly selected and killed by slitting the throat for the determination of carcass and organ (heart, gizzard and liver) weights. Birds fed with the conventional feed showed the highest carcass and organ weights and fat contents while the birds fed with 5% Moringa showed the lowest values. In addition, during the experimental period, the following parameters were examined: growth performance and feed intake. The results showed that the conventional feed intake increased with time, while the other batches showed low and constant feed intake for the first two weeks. An exponential rise in feed intake was observed from the third week up to the 6 week with batch 4 having the second highest intake to the conventional feed. Furthermore, the colour the meat in the four batches was the same throughout the period of the whole investigation and no bird died during these six weeks. It was concluded that the concentrations which were used in the investigation had no harmful effect to the health of the broilers. Furthermore, batch 4, which was fed with 15% Moringa showed results which almost compatible with those in the first batch, which was fed with the conventional feed. However, there is need to carry out more studies on the concentrations of *Moringa oleifera* which may produce the excellent optimum results in the broiler breeding industry.

**Keywords:** *Moringa/ Moringa oleifera, broiler, feed*

## **EVALUATION OF THE EFFICACY OF AN ANTIFUNGAL EXTRACT PRODUCED USING CITRONELLA OIL AND AJOENE ON REDUCING THE GROWTH OF *TRICHOPHYTON RUBRUM*.**

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Many people are prone to fungal infections on skin since fungi are highly contagious that is it can be spread easily and can be spread by sharing foot wear and clothing. Although infections caused by *Trichophyton rubrum* are considered to be mild and less harmful, if left untreated they can result in opportunistic infections such as *Pseudomonas* infections which affect the punctured skin. *T. rubrum* infections are accompanied with symptoms that are irritating and cause discomfort therefore there is need to find solutions that reduce growth of *T. rubrum* on feet. Also, currently on the market there are antifungal creams, powders and foot wash products therefore the evaluation of an antifungal extract produced from citronella oil and ajoene will bring variety to the market hence increasing the

availability of antifungal products, and reducing chances of resistance. The active ingredients used are sourced from indigenous plants, lemon grass and garlic which are easy to gain access to. The main aim of the project was to evaluate the efficacy of an antifungal extract produced using citronella oil and ajoene for reducing the growth of *T. rubrum* and the main objective is to determine the extent to which ajoene and citronella oil inhibit fungal growth. This was done using agar broth dilution, agar well diffusion and disk diffusion methods. After carrying out the experiment it was found out that both citronella oil and ajoene inhibited the growth of *T. rubrum* but citronella oil inhibits the growth more at a low concentration of 0,6ug/l as compared to ajoene which inhibits the growth at higher concentration of 1ug/l. The results obtained using disk diffusion method did not show any inhibition of fungi and this might be due to poor absorption of the active ingredients upon soaking or maybe the extract did not diffuse into the media and remained attached to the disk. From the experiment, it can be concluded that both ajoene and citronella oil inhibit the growth of *T rubrum*.

**Keywords:** Trichophyton rubrum, antifungal, citronella, ajoene

## **PRODUCTION OF A SKIN CARE CREAM FROM *BULBINE FRUTESCENES***

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In this study, a skin care cream was formulated from herbal extracts from *Bulbine frutescenes* leaves and roots. The objectives of the study were to extract anthraquinones from the roots and the leaves of *Bulbine frutescens*, to test the inhibitory effect of the anthraquinones on the growth of *S.aureus* and *C.albicans*, to formulate an antimicrobial skin care cream and test its efficacy and inhibitory effect on the growth of *S.aureus* and *C. albicans*. The anthraquinones from the *Bulbine frutescens* plant were successfully extracted by soaking the roots and leaves in an immiscible organic solvent mixture of dichloromethane and methanol at a ratio of 1:1. The zones of inhibition measured for the leaf and root extract for *S. aureus* grown on nutrient agar plates showed average diameters of 0mm, 0.8mm, 3.5mm and 5.2mm at 25%, 35%, 45% and 75 % concentration of crude extract of *Bulbine frutescens* respectively. The zones of inhibition measured for the leaf and root extract for *C. albicans* grown on potato dextrose agar plates showed average diameters of 0mm, 0mm, 1.8mm and 3.2mm for 25%, 35%, 45% and 75 % crude extract of *Bulbine frutescens* respectively. In the formulation of the cream a combination of the 100% root and leaf extract was used since it showed the greatest zone of inhibition. The formulated cream gave maximum zones of inhibition of 7.1mm against bacteria and 4.8mm against fungi. The skin care cream (Organo-Q) was successfully formulated using 25 ml of

100% crude extract of *Bulbine frutescens* 6ml of vitamin E oil and 44ml of pure aqueous cream. However it is recommended that other work be done using a pure extract of the anthraquinones.

**Keywords:** *Bulbine frutescens*, anthraquinone, antimicrobial compounds

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## **EVALUATION OF THE INHIBITORY ACTIVITIES OF CRUDE PHENOLIC EXTRACTS FROM OKRA AND ROSEMARY ON ALPHA AMYLASE AND ALPHA GLUCOSIDASE IN THE CONVERSION OF STARCH TO GLUCOSE**

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The aim of this work was to evaluate the inhibitory activities of ethanolic extracts of *Rosmarinus officinalis* and *Albelmoschus esculentus*, Piper betel and on Wheat alpha amylase and Baker's yeast alpha glucosidase at varying concentrations. Diabetes mellitus is a clinical condition characterized by hyperglycaemia in which an elevated amount of glucose circulates in the blood plasma. Alpha amylase and alpha glucosidase inhibitors are used to achieve greater control over hyperglycaemia in type 2 diabetes mellitus. The present study intends to screen novel alpha amylase and alpha glucosidase inhibitors from natural sources like plants in order to minimize the toxicity and side effects of the inhibitors currently used to control hyperglycaemia. The alpha amylase inhibition assay showed that the ethanolic extracts of *Rosmarinus officinalis* (13,50µg/mL), *Albelmoschus esculentus* (65.86 µg/mL) and a combination of the two extracts (12.41µg/mL) exhibited 50% alpha amylase inhibition activity at the mentioned concentrations. The alpha glucosidase IC<sub>50</sub> for the plant extracts *Rosmarinus officinalis* (43.77 µg/mL), *Albelmoschus esculentus* (65.15 µg/mL) and combination of the two extracts (24.23 µg/mL). The results of the work therefore clearly indicate the potential of these extracts to manage hyperglycaemia.

**Keywords:** *alpha amylase*, *alpha glucosidase*, okra, rosemary, diabetes

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# DEPARTMENT OF PHARMACEUTICAL TECHNOLOGY

## **COSMECEUTICAL FORMULATION OF A HERBAL CREAM THAT TARGETS SYMPTOMS OF PSORIASIS AND ITS SECONDARY INFECTIONS USING *OPUNTIA MEGACANTHA*, *LAGENARIA SICERARIA* AND *STRYCHNOS SPINOSA***

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A cream is defined as a semisolid preparation, often medicated, intended for external application for skin and mucous membranes (Aulton et al, 2013). A herbal cream is a formulation which incorporates herbal plant extracts as the source of the medical treatment. Such treatments are on the rise, and have widespread use for various diseases and ailments. 80% of the African population uses some sort of herbal treatment, with countries like China, India, Nigeria, United States of America and organisations such as World Health Organisation investing much in the development of these herbal treatments (Tilburt et al, 2008). Psoriasis is an autoimmune disease characterised by hyper proliferation of skin cells and plaque formation on the skin surface, which can also be treated with herbal remedies. This project researches the alleviation of symptoms of psoriasis and avoiding secondary infections using extracts of *Strychnos spinosa* (*Orange Monkey Tree, Mutamba*), *Opuntia megacantha* (*Prickly pear cactus, Dhorofiya, Idolofiya*) and *Lagenaria siceraria* (*Bottle Gourd, Mapudzi*). The active components used were B-sitosterol from *O. megacantha*, Kaempferol from *L. siceraria* and Kaurenoic acid from *S. spinosa*. 75% ethanol, ethyl acetate and n-Hexane were used as solvents to extract B-sitosterol, kaempferol and kaurenoic acid respectively, while a rotary evaporator was used to isolate the extracts from their solvents. Successful identification tests were done for these extracts which are namely Salkowski reaction, Lead sub acetate test and Bromothymol and Litmus tests for B-sitosterol, flavonoids and acid respectively. A working formula was designed grouping the ingredients into two phases, that is oil and aqueous phases. The two phases were homogenised to produce a stable biphasic homogenous cream. After formulation of the herbal cream as per British Pharmacopoeia, 200g of brown cream was obtained and 100g of this was used to test the cream's stability. The cream had spreadability of 57mm using the parallel plate method, hence denoted as a semifluid. There was no phase separation after three 24hr cycles of freeze thaw test and no detectable change after 7 days of window ledge test. Minimum Inhibitory Concentration Tests were carried out on the 2%, 10%, 50% and 100% concentration extracts of *Strychnos spinosa* using *E. coli* and *S. aureus*. Results showed that the 10% concentration extract was capable of inhibiting 5.0mm. Concentrations less than that were found not to inhibit bacterial growth.

**Key words:** psoriasis, *Strychnos spinosa*, *Opuntia megacantha*, *Lagenaria siceraria*, *S. aureus*

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# FORMULATION OF A SAFE AND EFFICACIOUS POLYHERBAL MOUTHWASH FOR THE TREATMENT OF GINGIVITIS USING *PITOSPORUM VIRIDIFLORUM* (MUCHEMEDZAMBUYA) AND *ACANTHOSPERMUM HISPIDUM* (CHIDHONGI) EXTRACTS

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Gingivitis is a periodontal disease affecting between 60 and 90% worldwide. Mouthwashes play a significant role in managing Gingivitis. There has been interesting debate on the link between alcohol based mouthwashes and oral cancer. This has led to calls for the banning of alcohol based formulations of mouthwashes and the need for safer alternatives. The project aimed to formulate a poly herbal mouthwash which has antibacterial activity against carcinogenic bacteria, antioxidant activity with alcohol free and ultimately efficient in treating gingivitis. Free radicals, bacteria activity and inflammation are linked to gingivitis. Managing them with concomitant brushing of teeth minimize the risks of Gingivitis. A poly herbal mouthwash formulated using *Acanthospermum hispidum* and *Pittosporum viridiflorum* hydroalcoholic extracts. The extract was obtained from leaves of *Acanthospermum hispidum* and *Pittosporum viridiflorum* which were independently macerated in 25% ethanol for 14 days. Both extract contained steroids, saponins, phytosterols, phenols and flavonoids. The formulation was then prepared and its anti-microbial activity was compared with the marketed mouthwash. From the results the polyherbal mouthwash has some anti-bacterial properties against E.coli. The poly herbal mouthwash exhibited some free radicals scavenging activities, whereas none was observed in the commercial mouthwashes. The poly herbal mouthwash stored on the shelf and in the refrigerator for observation purposes for 30 days and it was stable after 30 days. Combination of different herbal extracts lead to synergy, better activity and stability. The results showed that this poly herbal mouthwash has promise in improving the oral hygiene and preventing Gingivitis.

**Keywords:** Gingivitis, polyherbal, mouthwash, *Acanthospermum hispidum*, *Pittosporum viridiflorum*, steroids, saponins, phytosterols, phenols, flavonoids

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## **DEVELOPMENT OF AN ANTHELMINTIC CREAM THAT ALLEVIATES CUTANEOUS LARVA MIGRANS USING SELECTED ZIMBABWEAN PLANTS.**

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Helminthic infections are a global problem with serious socioeconomic repercussions especially in third world countries, like Zimbabwe. The present study aims to carry out the extraction, characterisation and identification of bioactive compounds, from the plant species *Ziziphus mucronata*, *Lantana camara* and *Datura stramonium*, with anthelmintic properties against sandworm and use them to formulate a suitable drug dosage form to treat cutaneous larva migrans (CLM). The methodology employed involved extraction of crude plant extracts and the in-vitro tests for the anthelmintic activity. In this study crude extracts of *D. stramonium* seeds, *L. camara* leaves and *Z. mucronata* from Zimbabwe were tested for anthelmintic activity against the sandworms with Albendazole as the positive control and normal saline (NaCl 0.9%) as a negative control. Phytochemical tests on the crude extracts were carried out to identify phytoconstituents up to the level of the class of compounds present that is alkaloids, tannins and so on. In-vitro tests were carried out against living sandworms species that cause CLM, paralysis time and death time in minutes were noted. All the used samples used significantly demonstrated paralysis and also caused death of worms in a dose dependent manner. All three crude extracts tested positive for tannins, flavonoids and alkaloids which contributed to the anthelmintic activity of the plant species. The crude extract of *Lantana camara* showed the greatest anthelmintic activity and 25g of this extract was used as the active ingredient in formulating a cream that ameliorate the symptoms associated with cutaneous larva migrans incorporating. The cream showed very high anthelmintic activity as noted by a paralysis time of 8 minutes and a death time 15 minutes. The cream also showed high stability after having subjected it to many stability tests including accelerated stability test, window ledge test, freeze thaw test etc.

**Keywords:** *Anthelmintic, Cutaneous larva migrans, Phytochemical screening.*

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## **FORMULATION OF AN ANTIBACTERIAL CREAM AND A LOTION TO TREAT FOLLICULITIS BARBAE USING *MUSA SAPIENTUM* PEELS**

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Folliculitis is a dermatological condition which causes inflammation of the hair follicles. It is caused

by the bacteria *staphylococcus aureus*, a highly resistant gram positive cocci. The condition can be divided into two categories which are, superficial and deep folliculitis. Superficial folliculitis can be *pseudo folliculitis barbae* which can progress to *folliculitis barbae*. Folliculitis can also be termed shaving bumps. The current treatment of folliculitis in Zimbabwe as guided by EDLIZ is Cloxacillin and Erythromycin administered four times a day orally. This treatment regime is not in sync with the global trends of moving away from systemic antibiotic use for conditions that can be treated by topical antibiotic therapy. The current method yields poor patient compliance. As a consequence, there are increased risks of bacterial resistance which have resulted in a need to use natural herbal topical formulations. The aim of this project was to formulate a herbal cream and lotion containing *musa sapientum* (Banana) peel extracts, which are reported to possess strong anti-bacterial activity against *staphylococcus aureus*. *Musa sapientum* was extracted using solvent extraction method and formulated into a lotion and a cream. Phytoconstituents tests were carried out and the extracts proved to contain alkaloids, tannins, flavonoids, steroids, saponins and steroids. The effectiveness of the product was determined using MIC test and at 10% a minimum inhibitory was reached which is comparable with Bactroban. Quality evaluation of the product was assessed by freeze thaw test, spreadability test and window ledge analysis. Stability parameters like visual appearance, nature, spreadability, viscosity, phase separation and fragrance of the formulations showed that there was no significant variation during the study period. The project results indicated that the *Musa Sapientum* peel extracts had significant efficacy against *S. Aureus* and could be used as a potent regular active pharmaceutical ingredient for the formulation of an antibacterial aftershave.

**Key words:** *Folliculitis, dermatological, musa sapientum, Musa Sapientum peels, shaving bumps, staphylococcus aureus, herbal lotions, herbal creams*

## **FORMULATION OF ANTI-FUNGAL CREAM FROM *FICUS SYCOMORUS* AND *LAMPRANTHUS FRANCISCI* TO TREAT CANDIASIS**

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Skin infections like topical candidiasis are often considered trivial, however these infections are in fact frequently intractable and recurring. The need to alleviate the signs and symptoms of candidiasis conditions saw the incorporation of various plant active extracts from *L.franscisi* and *F.sychomorus* to formulate a herbal antifungal cream. The plant phytochemicals were extracted using methanol and

chloroform and then purified using a rotary evaporator which drove off the methanol and chloroform which is harmful to the skin. The tincture produced was incorporated into a cream together with other excipients. The efficacy of the product was evaluated by means of Minimum Inhibitory Concentration (MIC) tests, in which the MIC range of the extract was shown to be 0.03- 4.0µg/ml. The MIC tests were done on *Candida albicans* which is a fungi that is responsible for candidiasis infections.

**Key words:** *Lamprantus francisci* and *Ficus sychomorus* antifungal.

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## **FORMULATION OF AN ANTI-BACTERIAL PREPARATION EFFECTIVE AGAINST CAUSITIVE AGENTS OF CELLULITIS USING SELECTED INDEGENOUS ZIMBABWEAN PLANTS (*Annona stenophylla* and *Parinari curatellifolia*)**

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The project aimed to produce an antibacterial product which effectively combat dermatopathic conditions specifically Cellulitis of the extremities, facial cellulitis, periorbital and orbital cellulitis, breast cellulitis and pre-anal cellulitis. Our main objective was to produce products which are able to deal with problems arising from resistant strains of bacteria and affordability of the products to the financially constrained. *Annona stenophylla* roots and leaves and barks for *Parinari Curatellifolia* were pulverized. The *Parinari Curatellifolia* leaves and barks were dried and crushed into a powder and weighed 640g of the powdered mass. Alcohol and water were mixed in the ratios 75% and 25% respectively and the mixture was allowed to stand for 14 days with periodic shaking in amber bottles. Also the 1000 g of fresh *Annona stenophylla* roots were collected and macerated. 1000 ml of solvent was used (ethanol (100%) and chloroform in a 1:1 ratio). The mixture was put in an amber bottle. Extraction was left to take place for 14 days after which the *Annona*-solvent mixture was filtered. The layers were taken separately and put into the rotary evaporator for extraction of the constituents. Temperatures of 64 and 69 degrees were used for chloroform and methanol respectively to evaporate them.

Cellulitis is mainly caused by the bacteria called *Streptococcus pyogenes* and *Staphylococcus aureus*, often community acquired MRSA is the most likely pathogen when these factors are present. However these bacteria were used in the Minimum Inhibitory Concentration investigations using the Test Tube Serial dilution method. 10% *Staphylococcus Aureus* showed an Inhibition Diameter Zone of 9mm which was measured using a vernier calipers. There was no significant difference between

the sample means of the extract inhibitions and Amox-Clav (amoxicillin+clavulanic acid) inhibitions. The results authenticated the claim we made of the antibacterial properties exhibited by *Annona stenophylla* extract which contains the anthraquinones. *Parinari Curatellifolia* showed a significant antibacterial effect compared to the sample means of IDZs of cloxacillin. An elegant and considerably stable white cream was produced at the end of the project.

**Key words:** inhibition diameter zone, amoxicillin, clavulanic acid, cloxacillin, *Annona stenophylla*, *Parinari Curatellifolia*

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