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COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF

CHEMICAL ENGINEERING (PROCESS STREAM)

PROJECT ON PRODUCTION OF ANTI-COCKROACH POWDER FROM BORIC ACID AND SILICA GEL

A THESIS SUBMITTED IN PARTIAL FULFILMENT FOR THE REQUIREMENT OF THE BACHELOR OF SCIENCE DEGREE IN CHEMICAL ENGINEERING

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This is to certify that the thesis prepared by Nuri Husen, Bagashaw Banti ,Sefu temam,Elias Feleke and Hana Barihun entitled on Production of ant-cockroach powder which is submitted to the department of chemical engineering in partial fulfillment of the requirement for the degree of bachelor of science in chemical engineering complies with the regulation of the university and meets the accepted standards with respect to originality and quality. .

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Declaration

We declare that our project which is called “Production of anti-cockroach powder for the BSc. degree at wolkite University is our original work and that all reference materials contained here have been duly acknowledged.

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Abstract

Cockroach is an insect which consumes wide ranges of food and it can cause different kinds of problems such as health problem, economic problems. Cockroach has lived many centuries on the earth and caused many dangerous conditions, starting from consuming rotting garbage to other different kind of food. For these problems starting from manually to scientifically, partial solutions were founded including using different chemicals that used to ride and kill it. In more the anti -cockroach powder with optimum active ingredient and attractant must be combined in order to solve the problem more from the problem was solved before, special proper mixing ratio of ingredients, proper attractant and active ingredients combination was our main issue. The cockroach killing powder was produced by combining boric acid, silica gel and peanut seed powder as attractant. The grinding, drying and mixing process was takes place. The sample could kill cockroach fast and was easy to use, proper cost and no harm to human and for animal. For the production of anti- cockroach powder, the material selection, characterization of those raw materials starting from their physical properties to chemical properties, the impacts of the chemicals on cockroach with and without attractant and the proper sampling and experimental designing for the production of the anti-cockroach powder were investigated.

The experimental results were recorded with necessary time interval and the performance of each sample was compared with one another The obtained results indicated that the boric acid powder also has very great dehydrating impacts with different points of mixing ratio. Relatively in all aspects, time of attraction, cost of the sample and the impacts on the cockroach, silica gel (20%) and peanut seed(70%) mixture more than boric acid and peanut seed mixture. From the economic point of view, the rate of return on investment provides 26.5% and the payback period is 2 years. Moreover, there is a positive value for the net present worth.

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Acronyms

WKU: Wolkite university

U.S.A: Untied state of America

DDT: dichlor-diphenyl – trichlorethane

DDD: dichlor- diphenyl-dichlorethane

NPV: Nuclear polyhedrosis virus

ULV: Ultra-low volume

BHC: benzene- hexachloride

WHO: World Health Organization

IGR: Insect growth regulators

ROR: Rate of return

MAR: Minimum acceptable rate of return

PBP: Payback period

CHAPTER ONE: Introduction

1.1. Background

Cockroaches are among the most common pests in many homes and other buildings. At night they search for food in kitchens, food storage places, rubbish bins, drains and sewers. They are pests because of their filthy habits and bad smell. Some people may become allergic to cockroaches after frequent exposure. Cockroaches can sometimes play a role as carriers of intestinal diseases, such as diarrhea, dysentery, typhoid fever and cholera.

Cockroaches have existed for millions of years, and there are thousands of species throughout the world today. Some of the most common species include German cockroaches, American cockroaches, brown-banded cockroaches and Oriental cockroaches. There are actually 4,500 species of cockroaches in the world. But just 30 are considered pests. Of those 30, however, four especially excel at making a nuisance of themselves the German, American, Australian and Oriental cockroaches.

There have been different kinds of cockroach controlling methods. Among these methods repelling of cockroaches by using different plants such as bay leaves, catnip, rosemary and etc, the others were killing of cockroaches by using different chemicals in different states (solid and liquid). In liquid state for example neem oil, essential oils, lavender oil etc, but the others were in solid state such as baking soda with sugar, boric acid, silica and etc.

Until recently, efforts to suppress cockroach populations in the urban environment have relied almost exclusively on repeated applications of synthetic pesticides. Surveys have shown that more than 1/ 3 of all the pesticides used in the U.S.A are applied in urban environments and most of these pesticides are applied in the home. However, the chemical approach to cockroach control has become increasingly less popular. This is primarily due to the development of multi-chemical resistance among German cockroach populations and increased public concern about pesticide exposure in their living environment. These two issues have greatly emphasized the need for a more holistic and less toxic approach to cockroach management.Cockroach has been one of among household pests.

1.2. Statement of problem

In the world Cockroaches may become pests in homes, schools, restaurants, hospitals, ware houses, offices and virtually in any structures that has food preparation or storage areas. They contaminate food and eating utensils, destroy fabric and paper products and and unpleasant odour to surface they contact. the cockroach's ability to contaminate food, rapidly reproduce, spread disease, disturb customers, in addition it cause food borne-disease bacteria that cockroaches can transmit in their faces and saliva, they can carry these pathogens Salmonella, Listeria, and Campylobacter on their bodies contaminating surfaces by simply walking on them. Until now these problems have been solved partially due to its high resistivity in nature towards different chemical those have been produce to control it. to solve these problems using chemicals in optimum mixing point can be more advisable than using the other chemicals those are not mixed in such away. it is necessary to find an alternative method which would produce the effective anti-cockroach powder. And another important of conducting this project is to produce anti-cockroach powder in our country in order to reduce the amount insecticide import from a broad to reduce the cost of taxation import. This helps us to increase the economy of our country.

1.3. Objectives

1.3.1. Main objective

The general objective of this study is to produce ant – cockroach powder from boric acid and silica gel.

1.3.2. Specific objectives

- To produce cockroach killer based on DE hydrant and attractant.
- To determine feasibility of the project.
- To optimize product performance versus production cost.
- To study the characteristics of raw materials.
- To compare and recording each active ingredients and attractant impacts on cockroaches were occurred solely.
- Comparison of the effect silica gel powder with that of the boric acid powder on cockroach.

1.4. Significance of the study.

This project will contribute significantly to produce ant-cockroach powder from boric acid and silica gel within the country and expand the product in the country to help the people as to get quality product of the powder in simple way ,because of the anti-cockroach is imported These factory will create job opportunity and contributes to the economic development activity by Producing effective anti-cockroach powder in low cost at optimum point through reducing cost of importing ant-cockroach powder from abroad.

This project helps to understand and adds to the knowledge of the production of ant-cockroach powder from attractant and active ingredient at optimum point, performance and cost

CHAPTER TWO: Literature Review

2.1. Insecticides

Insecticides are substances used to kill insects. They include ovicides and larvicides used against insect eggs and larvae, respectively. Insecticides are used in agriculture, medicine, industry and by consumers. Insecticides are claimed to be a major factor behind the increase in the 20th-century's agricultural productivity. Nearly all insecticides have the potential to significantly alter ecosystems; many are toxic to humans and/or animals; some become concentrated as they spread along the food chain. Insecticides can be classified into two major groups: systemic insecticides, which have residual or long term activity; and contact insecticides, which have no residual activity [1].

Any toxic substance that is used to kill insects, such substances are used primarily to control pests that infest cultivated plants or to eliminate disease-carrying insects in specific areas. Insecticides can be classified in any of several ways, on the basis of their chemistry, their toxicological action, or their mode of penetration. In the latter scheme, they are classified according to whether they take effect upon ingestion (stomach poisons), inhalation (fumigants), or upon penetration of the body covering (contact poisons). Most synthetic insecticides penetrate by all three of these pathways, however, and hence are better distinguished from each other by their basic chemistry. Besides the synthetics, some organic compounds occurring naturally in plants are useful insecticides, as are some inorganic compounds; some of these are permitted in organic farming applications. Most insecticides are sprayed or dusted onto plants and other surfaces traversed or fed upon by insects [3].

An insecticide is a substance used by humans to gain some advantage in the struggle with various insects that are considered "pests." In the sense used here, a pest insect is considered undesirable, from the human perspective, because: (a) it is a vector that transmits disease causing pathogens to humans (such as those causing malaria or yellow fever), or other diseases to livestock or crop plants; or (b) it causes a loss of the productivity or economic value of crop plants, domestic animals, or stored foodstuffs. [3]

The mode of action describes how the pesticide kills or inactivates a pest. It provides another way of classifying insecticides. Mode of action can be important in understanding whether an insecticide will be toxic to unrelated species, such as fish, birds and mammals. Insecticides may be repellent or non-repellent. Social insects such as ants cannot detect non-repellents and readily crawl through them. As they return to the nest they take insecticide with them and transfer it to their nest mates. Over time, this eliminates all of the ants including the queen. This is slower than some other methods, but usually completely eradicates the ant colony [3].

The abundance and effects of almost all insect pests can be managed through the judicious use of insecticides. However, the benefits of insecticide use are partly offset by important damages that may result. There are numerous cases of people being poisoned by accidental exposures to toxic insecticides. More commonly, ecological damage may be caused by the use of insecticides, sometimes resulting in the deaths of large numbers of wildlife [2].

2.1.1. Features of insecticides

Insecticides can be directed against the larval stages of mosquitos, which live in water, or against free-living adult stages. In the latter case they can be applied in two ways:

- Release into the air in the form of a vapour or aerosol, by means, for example, of mosquito coils and aerosol spray cans and by space-spraying. This method knocks down or kills flying and resting insects immediately after they absorb the particles by inhalation or contact, but offers only brief protection.
- Application to a surface as a spray or deposit or impregnation for prolonged action. Residual insecticides kill insects that land on or crawl over a treated surface. The duration of action depends on many factors, such as the nature of the surface, the insecticide, its formulation and the dosage. Examples are insecticidal dusts used against lice and fleas, impregnated mosquito nets and residual spraying of the walls in a house.

  Different insecticides are suitable for different application methods. For example insecticides that evaporate quickly at ambient temperature are not suitable for residual application on walls; they may, however, be suitable for use in vaporizers or space sprays [2].

2.1.1.1. Moisture content

More pesticide were more dissipated at bio bed moisture levels of 60% water holding capacity (WHO) than at 30% and 90% WHC,while 20˚C gave higher dissipation rates than 2 and 10˚C. Astraw:peat:soil ratio of 50:25:25% v/v is recommended in field bio beds since this produces high microbial activity and low ph,favourable for lignin-degrading fungi and phenol oxidase activity[4]

2.1.1.2. Attractant

Insect Attractants for “Good” and “Bad” Insects attractant formulations are based on naturally-occurring semi chemicals and can be used to help or protect crops in several ways. The most popular use of attractants is to lure pests to traps for control via the mass trapping strategy. Attractants can also be used to induce beneficial insects to come to and stay in crops for goals such as enhanced pollination or natural pest protection semi chemical insect attractants are made up of compounds-like pheromones, plant volatiles, flower oils, sugars and proteins-that mimic insect attraction systems found in nature. By identifying processes already existing in nature, can use them to create sustainable technologies to manage insects [5].

Characteristics of good residual insecticides

A residual insecticide should be:

- Highly toxic to target insects. Insecticides may lose their effectiveness if the target insects develop resistance. From time to time, samples of the target insect should be collected and checked for the development of resistance. If resistance is observed another insecticide without cross-resistance has to be used.
- Long-lasting on a given surface. The toxicity should remain high over a sufficiently long period to prevent the need for frequent reapplication, which is costly and time-consuming.
- Not repellent or irritant to target insects to ensure that the insects pick up a lethal dose.

Kinds of Insecticides

Insecticides are an extremely diverse group of chemicals, plus additional formulations based on living microorganisms. The most important groups of insecticides are described below.

1. **Inorganic insecticides:** are compounds containing arsenic, copper, lead, or mercury. They are highly persistent in terrestrial environments, being slowly dispersed by leaching and erosion by wind and water. Inorganic insecticides are used much less than in the past, having been widely replaced by synthetic organics. Examples of insecticides include Paris green (a mixture of copper compounds), lead arsenate, and calcium arsenate.
2. **Natural organic insecticides:** are extracted from plants. They include nicotine extracted from tobacco (usually applied as nicotine sulphate), pyrethrum extracted from daisy-like plants, and rotenone from several tropical shrubs.
3. **Chlorinated hydrocarbons:** (or organochlorines) are synthetic insecticides, including DDT and its relatives DDD. Residues of organochlorines are quite persistent in the environment, having a half-life of about 10 years in soil. They are virtually insoluble in water, but are highly soluble in fats and lipids. Their persistence and strongly lipophilic nature causes organochlorines to bio-concentrate and to further food-web magnify in high concentrations in species at the top of food webs.
4. **Organophosphate insecticides**:include fenitrothion, Malathion, parathion, and phosphamidon. These are not very persistent in the environment, but most are extremely toxic to arthropods and also to non-target fish, birds, and mammals.
5. **Carbamate insecticides**: include aldicarb, aminocarb, carbaryl, and carbofuran. They have a moderate persistence in the environment, but are highly toxic to arthropods, and in some cases to vertebrates.

6. Synthetic pyrethroids: are analogues of natural pyrethrum, and include cypermethrin, deltamethrin, permethrin, synthetic pyrethrum and pyrethrins, and tetramethrin. They are highly toxic to invertebrates and fish, but are of variable toxicity to mammals and of low toxicity to birds. More minor groups of synthetic organic insecticides include the formamidines (e.g., amitraz, formetanate) and dinitrophenols (e.g., binapacryl, dinocap).

7. Biological insecticides: are formulations of microbes that are pathogenic to specific pests, and consequently have a relatively narrow spectrum of activity in ecosystems. An example is insecticides based on the bacterium Bacillus thuringiensis (or B.t.). There are also insecticides based on nuclear polyhedrosis virus (NPV) and insect hormones [6].

2.2. Ingredients

An insecticidal chemical synthesized by a manufacturer or laboratory prior to its further processing is known as technical grade compound. Technical grade insecticides often have high purity (e.g., greater than 95%). The essential component of a technical grade insecticide is the active ingredient (A.I.) that exerts toxic actions on an organism. However, technical grade insecticides are seldom used directly for pest control because their chemical and physical properties often are not suitable for commercial use. Therefore, technical grade insecticides should be brought into more appropriate forms (i.e., formulations) for their application, either as sprays, powders, granules, fumigants, baits, seed dressings, or other types of formulations[6].

The process of insecticide formulation involves the use of various methods to improve the properties of an insecticidal compound for storage, handling, application, efficacy, or safety. Typically, insecticides are formulated by mixing the active ingredients and auxiliary materials. Most auxiliary materials are inert; they serve strictly as carriers for active ingredients and have no direct effect on pests. However, other auxiliary materials, including synergists, surfactants (wetting agents, spreaders, emulsifiers, and dispersing agents), foam suppressants, and stickers, have important properties and functions[6].

Formulated insecticides are the final physical state that may be sold under the formulator's designated brand names. Because one insecticide active ingredient may be formulated into several different formulations for different applications, the same active ingredient may have several different formulations under different brand names. In 1997, approximately 20,700 formulations, representing 891 registered active ingredients of pesticides (insecticides, herbicides, fungicides, and others), were sold in the United States [6].

Table 1 Common Insecticide Formulations and Their Characteristics

Formulation	**Characteristics**
Aerosol (A)	An active ingredient is dissolved in an oil solvent (or liquid carbon dioxide) and propellant. The insecticide is applied as a gas-propelled spray through a fine opening into closed or confined areas.
Bait (B)	An active ingredient is mixed with an **edible (waan nyaatamu)** or attractive substance.
Dust (D)	An active ingredient is mixed with a dry inert diluent (e.g., talc, clay). The formulated insecticide can be suspended easily in air.
Emulsify able concentrate (EC)	An active ingredient is dissolved in an oil-based solvent (toluene) and mixed with an emulsifying agent which permits the formulation to mix with water to form an emulsion.
Flow able (F or L)	An active ingredient is wet-milled with a clay diluent and water to produce a gel-like material that can be measured as a liquid and mixed with water to form a suspension for spraying.
Fumigant (F)	A volatile liquid or solid insecticide acts as a poisonous gas that is used in confined areas.
Granular (G)	A liquid insecticide is applied to coarse particles (20 to 80 mesh) of a porous inorganic material such as clay or organic material such as macerated walnut shells or oat bran.

Formulation	**Characteristics**
Microencapsulation	An insecticide (either liquid or dry) is encapsulated in permeable microscopic spheres or capsules to permit the release of the insecticide at a slow or consistent rate.
Soluble powder (SP)	An active ingredient is mixed with a finely-ground inert solid. The formulated insecticide can be dissolved completely in water or other liquid to form a true solution.
Solution (S)	A concentrated liquid insecticide formulation may be used directly or mixed with water to form a true solution.
Ultra-low volume (ULV)	An insecticide concentrate can be sprayed undiluted at 0.6 to 4.7 litters per hectare as finely dispersed droplets.
Wet table powder	An active ingredient is mixed with an appropriate inert solid (e.g., talc, diatomaceous earth) and a wetting agent which permits the powder to mix with water to form a suspension.

Many different types of insecticide formulations are currently available. Choosing the most appropriate formulation for a particular pest management project is critical to effective and safe uses of insecticides. The most important question to ask in choosing an insecticide formulation is whether or not the product is labelled for the insect and crop or circumstance for which application is intended. In the United States, the State Agricultural Experiment Stations and Cooperative Extension Services are excellent sources for recommending the most appropriate insecticides and formulations for particular pest management problems.

- Pesticide regulation: Whether or not the product is labelled for the insect pest and crop or circumstance for which application is intended.
- Type of environment: Some formulations may be more suitable for certain environmental settings (agricultural, urban, aquatic, etc.).
- Plant, animal, or surface to be protected: Some formulations may be phytotoxic, absorbed by the animal, or may pit and mar surfaces.
- Availability and suitability of application machinery: Some formulations require constant agitation or specialized equipment.
- Hazard of drift or run-off: Some formulations have greater hazard of drift or run-off than others. Proximity to sensitive areas and the likelihood of wind or rain should be considered.
- Safety to applicator and non-target animals: Insecticide exposure to an applicator and non-target animals can be significantly reduced by choosing an appropriate formulation.
- Habits or growth patterns of the pest: Some formulations may be more suitable to control pests in certain habits or at certain developmental stages.
- Cost: The price, efficacy and application of different formulations of the same insecticide may affect overall cost.

2.2.1. Benefits of Insecticide Use

Humans have attained important benefits from many uses of insecticides, including:

1. Increased yields of crops because of protection from defoliation and diseases;
2. Prevention of much spoilage of stored foods; and
3. Prevention of certain diseases, which conserves health and has saved the lives of millions of people and domestic animals.

2.2.2. Environmental impact

Effects on non-target species Some insecticides kill or harm other creatures in addition to those they are intended to kill. For example, birds may be poisoned when they eat food that was recently sprayed with insecticides or when they mistake an insecticide granule on the ground for food and eat it. Sprayed insecticide may drift from the area to which it is applied and into wildlife areas, especially when it is sprayed aerially [9].

The advent of synthetic insecticides in the mid-20th century made the control of insects and other arthropod pests much more effective, and such chemicals remain essential in modern agriculture despite their environmental drawbacks. By preventing crop losses, raising the quality of produce, and lowering the cost of farming, modern insecticides increased crop yields by as much as 50 percent in some regions of the world in the period 1945–65. They have also been important in improving the health of both humans and domestic animals; malaria, yellow fever, and typhus, among other infectious diseases, have been greatly reduced in many areas of the world through their use [9].

But the use of insecticides has also resulted in several serious problems, chief among them environmental contamination and the development of resistance in pest species. Because insecticides are poisonous compounds, they may adversely affect other organisms besides harmful insects. The accumulation of some insecticides in the environment can in fact pose a serious threat to both wildlife and humans. Many insecticides are short-lived or are metabolized by the animals that ingest them, but some are persistent, and when applied in large amounts they pervade the environment. When an insecticide is applied, much of it reaches the soil, and groundwater can become contaminated from direct application or runoff from treated areas. The main soil contaminants are the chlorinated hydrocarbons such as DDT, aldrin, dieldrin, heptachlor, and BHC. Owing to repeated sprayings, these chemicals can accumulate in soils in surprisingly large amounts (10–112 kilograms per hectare [10–100 pounds per acre]), and their effect on wildlife is greatly increased as they become associated with food chains.

The stability of DDT and its relatives leads to their accumulation in the bodily tissues of insects that constitute the diet of other animals higher up the food chain, with toxic effects on the latter. Birds of prey such as eagles, hawks, and falcons are usually most severely affected, and serious declines in their populations have been traced to the effects of DDT and its relatives. Consequently, the use of such chemicals began to be restricted in the 1960s and banned outright in the 1970s in many countries [10].

Cases of insecticide poisoning of humans also occur occasionally, and the use of one common organophosphate, parathion, was drastically curtailed in the United States in 1991 owing to its toxic effects on farm labour who were directly exposed to it. Another problem with insecticides is the tendency of some target insect populations to develop resistance as their susceptible members are killed off and those resistant strains that survive multiply, eventually perhaps to form a majority of the population. Resistance denotes a formerly susceptible insect population that can no longer be controlled by a pesticide at normally recommended rates. Hundreds of species of harmful insects have acquired resistance to different synthetic organic pesticides, and strains that become resistant to one insecticide may also be resistant to a second that has a similar mode of action to the first. Once resistance has developed, it tends to persist in the absence of the pesticide for varying amounts of time, depending on the type of resistance and the species of pest [11].

Insecticides may also encourage the growth of harmful insect populations by eliminating the natural enemies that previously held them in check. The nonspecific nature of broad-spectrum chemicals makes them more likely to have such unintended effects on the abundance of both harmful and beneficial insects [11].

Because of the problems associated with the heavy use of some chemical insecticides, current insect-control practice combines their use with biological methods in an approach called integrated control. In this approach, a minimal use of insecticide may be combined with the use of pest-resistant crop varieties; the use of crop-raising methods that inhibit pest proliferation; the release of organisms that are predators or parasites of the pest species; and the disruption of the pest’s reproduction by the release of sterilized pests [12].

2.2.3. Health impact

Many workers and residents, especially in the rural sector, are in contact with pesticides on a daily basis, so they are at high risk of poisoning by these compounds. This exposure can cause neuropsychiatric sequelae (mood disorders, depression, and anxiety), because many pesticides underlie changes in the function (e.g., cholinergic crisis) of the central, peripheral, and autonomic nervous system, which are often followed by suicide attempts. In addition to being causative agents of neuropsychiatric disorders that might culminate in suicide, these effects may lead to the use of pesticides as a weapon, aaccording to data released by the World Health Organization (WHO), suicide by pesticides is common in many Asian and Latin American countries. Pesticides are often poorly controlled and widely available, particularly in countries of low and middle income the first epidemiological reports of suicides involving pesticides appeared in the beginning of the 1990s. Currently, homicides and suicides involving pesticides have raised the concern of many organizations and governments as, depression and suicide clearly correlate with high exposure to pesticides. This concern has motivated and still motivates many studies into how and why exposure to pesticide occurs; researchers have also caught methods to solve this serious social problem [14].

- Safe to humans and domestic animals. There should be no danger to spray workers, inhabitants or animals accidentally contaminated with the insecticide during or after spraying.
- Acceptable to house owners. Some insecticide formulations are less acceptable because of their smell or because they leave unattractive deposits on walls.
- Stable during storage and transportation; mix well with water; harmless to spraying equipment.
- Cost-effective. Calculation of the cost should be based on how the insecticide is applied, at what dosage and how many times a year.

2.3. Cockroach

Cockroaches are among the most common insects. Based on fossil evidence, roaches are known to have been present on Earth for over 300 million years. Their sizes vary considerably; some species are up to several inches long. Some biologists consider insects to be one of the most successful groups of animals to ever inhabit this planet, and cockroaches are one of the most adaptable and successful insect groups. They have been able to survive many changing environments over millions of years. There are approximately 3500 species of cockroaches worldwide-about 60 species are found in the United States. Their presence in nearly every part of the world and wide range of habitats demonstrate that cockroaches are truly an outstanding success story in Nature. Unfortunately, many of the same outstanding biological characteristics which make them so successful also make them one of the most difficult pests to manage. Cockroaches, especially the German cockroach, are the most commonly encountered and important household insect pests in much of the U.S and other parts of the world [15].

Most cockroaches are tropical and sub-tropical in origin, generally live outdoors. They are mostly active at night, during which time they forage for food, water and mates. They may be seen in the daytime; particularly when a heavy population is present or when some other form of stress is placed on the population (such as lack of food or water). Cockroaches ordinarily prefer a moist environment, and many species also prefer a relatively high degree of warmth. Some tropical roaches feed only on vegetation. However, cockroaches which live in buildings are mostly scavengers and feed on a wide variety of food. They are especially fond of starches, sweets, grease, and meat products; but will also eat a great variety of materials such as cheese, beer, leather, bakery products, and starch in book bindings, glue, and hair, flakes of dried skin, dead animals and plant materials [17].

Cockroaches usually choose to live in protected cracks and crevices which provide a warm and humid environment. Some species, such as the American and oriental cockroaches, gather in large groups on open walls in protected places or in open areas outside. While they are often found in groups in their daytime hiding or resting areas (called "harborage"), and can be found feeding in groups at night, cockroaches are not social insects as are the ants and wasps. Cockroaches generally forage individually for food and otherwise behave in a largely individualistic or non-social manner.

Even though cockroaches are not social insects, they do often form aggregates. The general shape of a cockroach is familiar to everyone. They are oval and flat-bodied, which enables them to squeeze into all types of cracks and crevices. A pronoun (a shield-like covering) projects forward over the head; their mouthparts are of the chewing type and are oriented downward slightly toward the rear of their body. With their long spiny legs, they can run rapidly over most surfaces. Specialized pads in their tarsi allow them to easily scale glass windows or walk on a ceiling [11].

Besides their ability to move around inside and outside, and the fact that some species are good fliers, cockroaches are well known for moving to new areas via "hitchhiking." Because they prefer to hide in cracks and crevices in the daytime, they are frequently moved about by individual people or in products shipped around cities or the country. Careful inspection of furniture, clothing, or other goods coming into a home or other facility may reveal cockroaches hiding in these items. Careful observations by pest management professionals and researchers have shown surprising numbers of German cockroaches entering such facilities as hospitals, restaurants, zoos and supermarkets by these routes (every day in some cases)[12].

2.3.1. Types of cockroach

There are more than 4,500 types of roaches in the world, of which only around 69 species are found in the United States. And while that number is still pretty high, the good news is you really only have to worry about five or six different roach species, depending on which state you call home. Most species of roaches rarely invade homes, including the western wood cockroach and the brown-hooded cockroach (which prefers to live outside in the Pacific Northwest). But the news isn't all good. These handful of troublesome roach species that want to move in with you can easily become a nightmare for any homeowner. Consider that for every roach you can see, there's a good chance there are dozens, even hundreds, in your home that you can’t see. And while all roaches might look the same as they scatter when you turn on the lights, knowing how to tell the difference between the most common types of roaches in your home will help you choose the most effective pest control methods to stop the infestation dead in its tracks[7].

General appearance of all types of roaches

Cockroaches have flattened broad bodies with long antennae and long hind legs. Each of their six legs has tiny sensory hairs. Adult roaches have wings that fold flat on their backs, but not every cockroach can fly. Most roaches are brown or black and can range anywhere from 0.07 inches to 3 inches in length, depending on the species. One of the most distinctive features of a cockroach is the shield-shaped pronotum located directly behind the head. If you're observing a roach in your home, chances are it's either a German cockroach or a brown-banded cockroach. These are the two most common unwelcome inhabitants of homes, buildings and structures [16].

1. German cockroaches (light brown)

The German cockroach is the most common of all cockroach types found in America. Their high-speed capacity for breeding makes them a direct threat to your family and home. All it takes is one single female to get into your home. Between her and her offspring, more than 30,000cockroaches can be produced in one year, though many of them won't live very long. The ones that do survive are more than enough to cause disease and disgust, ach German cockroach egg case can hatch between 20 and 40 baby roaches, and unlike other types of cockroaches, the adult female carries the eggs with her until they are ready to hatch.

2. Brown-banded cockroaches

While German and brown-banded roaches might inhabit the same house, they rarely hide in the same spots. Brown-banded roaches prefer warmer, drier areas, especially up high and inside your electronics, television, refrigerator, etc. They tend to stay away from water.

3. American cockroaches

Though not the most common cockroach in American homes, the American cockroach is the largest, they can survive up to two years, much longer than other cockroach types. These roaches are more commonly called "palmetto bugs" and spotting one can be particularly alarming.

4. Smoky brown cockroaches

The smoky brown cockroach dehydrates very quickly so you will see these types of roaches in moist, damp places – if you see them at all. They are excellent fliers and extremely nocturnal, though they are attracted to light and will enter homes when they see it.

5. Oriental cockroaches

More commonly called "water bugs", the Oriental cockroach dwells in darkness and loves moist, damp spots that are out of sight and harm from humans. This makes them harder to get rid of without pest management professionals since pesticides might get washed away. No matter what types of cockroaches you have, you don't want them in your house or around your family. Roaches can transmit disease as they become contaminated with filth crawling on floors, into drain pipes or in other low places they may travel. Just a few minutes later, the very same roaches may be seen walking around on your clean dishes or on the food you've been preparing. The best way to make sure your home is roach-free is to call Termini and get a free pest evaluation [16].

2.3.2. Property of cockroach

Roaches are most active at night, during which time they forage for food and mate. Cockroaches are social insects that usually live in groups. Cockroaches emit pheromones that leave chemical odours in their faces and on their bodies. These pheromones serve as means of communication for the insects. Cockroaches (or roaches) are insects of the order Blattodea, which also includes termites. About 30 cockroach species out of 4,600 are associated with human habitats. About five species are well known as pests[7].

The cockroaches are an ancient group, dating back at least as far as the Carboniferous period, some 320 million years ago. Those early ancestors however lacked the internal ovipositors of modern roaches. Cockroaches are somewhat generalized insects without special adaptations like the sucking mouthparts of aphids and other true bugs; they have chewing mouthparts and are likely among the most primitive of living Neopteran insects[8].

They are common and hardy insects, and can tolerate a wide range of environments from Arctic cold to tropical heat. Tropical cockroaches are often much bigger than temperate species, and, contrary to popular belief, extinct cockroach relatives (Blattoptera) and 'roachoids' such as the Carboniferous Archimylacris and the Permian Apthoroblattina were not as large as the biggest modern species [19].

Some species, such as the gregarious German cockroach, have an elaborate social structure involving common shelter, social dependence, information transfer and kin recognition. Cockroaches have appeared in human culture since classical antiquity. They are popularly depicted as dirty pests, though the majority of species are inoffensive and live in a wide range of habitats around the world [19].

2.3.3. Cockroach killer

The present invention relates to a method of preparing powders and kill cockroaches, and more particularly to a powder preparation and a method of killing cockroaches in Chinese herbal medicine as a main component, belonging to the field of health insecticides. At present, drugs for the prevention and treatment of cockroaches There are two major categories, namely spray to spray to tag the main mode of administration of drugs (such as deltamethrin application) and to attractant, infectious death as the main feature of stomach poison particles type bait (e.g. cockroaches). The former is instrumentation, workload (required when moving furniture or other spraying equipment), the general context of disposable processing set are not effective, easy to pick up the density of cockroaches (not consolidate killing effect); as repeated processing, the workload doubled, to pay a lot of manpower, material and financial resources[19].

The most common formulations for cockroach control are sprays, dusts, and baits. Sprays Insecticides commonly used in indoor sprays include alethic, chlorpyrifos (DURSBAN), diazinon, permethrin, propoxur (BAYGON), pyrethrins, permethrin, and insect growth regulators (IGR) such as hydroprene or pyriproxyfen. Insect growth regulators will take 4 to 6 weeks for a noticeable decrease in the population. But control is longer lasting because the cockroaches are no longer able to reproduce once exposed. Evidence of insect growth regulator exposure is twisted wings on the adult cockroaches and altered behaviour. Expect to see more cockroaches during the day as a result of IGR use. Seeing more cockroaches after IGR use means the treatment is working. Dusts are slow-acting but can give long lasting control. Boric acid is probably the most commonly used dust labelled for cockroach control. It is most effective indoors in clean, dry areas. Apply boric acid with a duster that puts out a thin film of dust. Apply dusts in hidden areas such as under refrigerators, stoves, sinks, wall voids, and other cracks and crevices. Do not apply dusts in open areas such as on shelves or counters where food and utensils are kept. Boric acid is highly toxic to plants and will discolour some fabrics. Baits usually come in granular formulations, plastic stations, or large syringes for gel applications. Some commonly used insecticides in baits include chlorpyrifos (DURSBAN 0.5% BAIT), hydramethylnon (COMBAT ROACH BAIT STATIONS or GEL BAIT), sulfluramid (RAID MAX), and avermectin (ROACH ENDER). Apply granular formulations outside in plants and mulched areas. Bait stations are most effective when placed in corners where you suspect cockroaches are hiding or coming into your home [15].

Powder

Dusts are useful in cockroach control because they can be placed in deep in cracks, cervices and wall voids; under refrigerators and furniture; around pipes, tunnels and conduits; on very smooth and very rough surfaces; and other places not treatable with other formulations. Do not use dusts for treating large surfaces because the leave unsightly deposits. Also, cockroach avoid heavy deposits and will not walk through thick layer of materials. Use light pressure on the application device to minimize the amount of dust around living areas. Apply dusts as light, even residue that are barely visible. Dusts such as boric acid, silica aerogel, not apply dusts to wet or dump areas. Dusts should be applied lightly because heavy deposits may repel cockroaches. Do not place dusts where children or pets could come into contact with them and diatomaceous earth can be applied to voids and other harborages such as cracks and crevices[19].

Dust formulations contain an active ingredient plus a powdered dry inert substance like talc, clay, nut hulls, or volcanic ash. The inert ingredients allow the dust formulation to store and handle well. In households, dusts should be used only in locations where the inhabitants would not stir the dust, move it around, or inhale it. These have had dry, finely ground, powdery formulations added to water. They look like dusts, but a wetting agent has been added to the other ingredients to help them mix with water [19].

Boric acid powder: Boric acid, an inorganic white powder formulated as both a granular and agel bait. It has very low mammalian toxicity; however, caution must be taken to avoid accidental ingestion. The cockroach killing paste was produced by mixing boric acid, milk powder, sugar, honey and water in 30-40 C^o. It has been used to kill cockroach fast and has easy use, and no harm to human and farm animal [20].

Table 2.Bait from boric acid

Items	Ingredient type	Min %	Max %
Boric acid	Active/DE hydrant	25	40
Milk powder	Attractant	25	40
Sugar	Attractant	4	8
Honey	Attractant	1	2
Water	Attractant	20	30

2.3.4. Factors affecting the quality of the product of anti-cockroach powder

The quality of any product can be affected by different factors, those factors can be different in type, in the case of our study the quality of product ant cockroach powder can be affected by mixing ratio of ingredients and attractants. The materials used to mill roasted peanut seed could affect the quality of the product, it could decrease the attraction degree of peanut.

CHAPTER THREE: Material and Methods

3.1. Materials

The major materials needed for cockroach killing powder experimental works were de hydrants (boric acid , silica gel) the peanut seed powder as an attractant , miller , dryer, broom, sterilized dishes, cockroach culture box, cockroach collector from the field , sieve

Table3. Equipment's, chemicals and filler

A. Equipment	Purposes
1.cockroach culture box	Was for cockroach growth and experimenting.
2.cockroach holder	Was for collecting from different sources.
3.strilized dish	Was for mixing.
4.stick stirrer	Was for mixing particle more.
5.litmus paper	Was for checking the media of mixture.
6. sieve	Was for particle size distribution adjustment.
7. miller and beam balance	Was for grinding rough silica gel and measuring sample.
B Chemicals needed for	**Purposes**
1. Boric acid powder	Was used for dehydrating the cockroach system.
2.silica gel powder	Chemicals used as hygroscopic.
C filler	**Purpose**
1. Wheat flour	Enhancing the weight of the product.
D attractant	**Purposes**
1 peanut seed powder	Was for attracting the cockroach.

3.2. Methods

3.2.1. Design of hurdle

The hurdle was made from the timber. To prepare that rectangular hurdle, four 1m long and 0.5m wide timbers were needed. In addition to that for internal division, to prepare the hurdles which have gets at different position 10 timbers 0.5 m by 1m length and width respectively. Division assures that whether the cockroach would attracted and the strength of attraction of each sample as the attractant increased and decreased. The internal divisions were equal distant rather having the pathway at different position.

Figure 1.Hurdle design

3.2.2. Preparation of raw materials

Major identified raw materials for cockroach based powder production such as DE hydrant (boric acid, silica gel) and the peanut seed powder as attractants were collected and analysed using its standard, PH, density, particle size, and colour. Peanut seed and silica gel was ground to have nearly the same size to mix with others

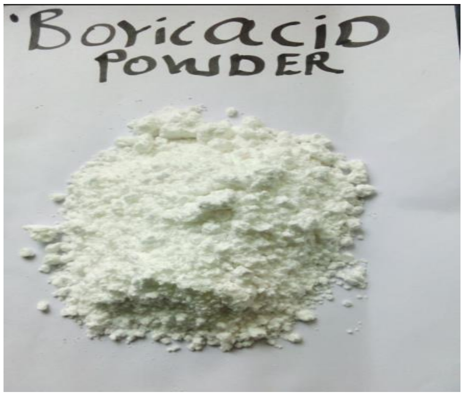


Figure 2. Boric acid powder

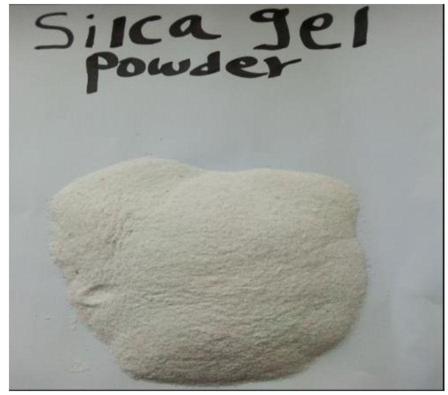


Figure 3.Silica gel powdered

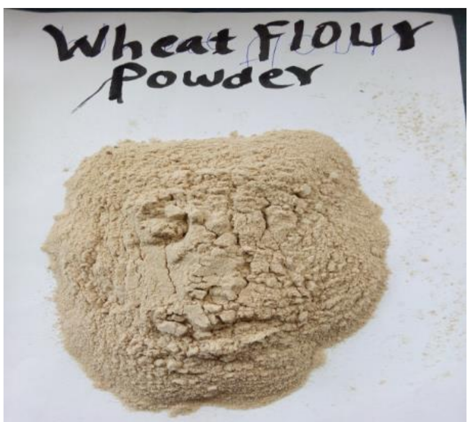


Figure 4.wheat flour powder

Figure 5.Peanut seed powder

3.2.2.1. Size reduction for the sample

Adjusting the particles size of each ingredient used for the preparation, and the sample size was measured and proper mixing ratio of each ingredient within the sample size was adjusted. Size of all the particle in the sample should be nearly the same and less than 10mm for the proper mixing of the raw material. Each raw material reduced in grinding mill to increase the amount of fine particle in the powder. Finally the optimum particle size was determined by using sieve with 60 meshes.

Figure 6.boric acid Silica gel container

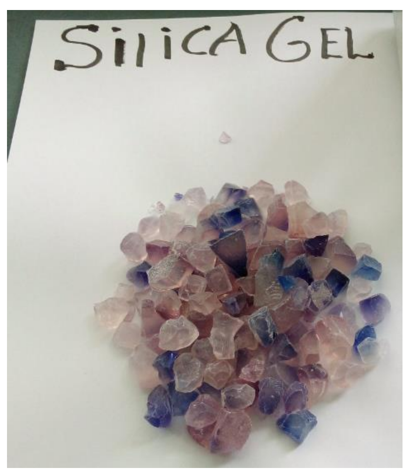


Figure 7.Size reducer for chemical

Figure 8.Silica gel before size is reduced

3.2.2.2. Measuring each ingredient for the sample

To produce 30g of sample each ingredient was measured before, as it needed for each sample. Firstly measured was the attractant, peanut 30g, active ingredient and filler 30g respectively. Before to prepare the sample with each ingredient, the same amount of sample was prepared from attractant only as well as also from DE hydrant in order to know individual impact on cockroach.

Figure 9.Peanut seed measuring

Figure 10.boric acid measuring

3.2.3. Experimental design

In order to have more understanding on one scientific area as well as engineering issue, experimental design is very crucial. Therefore, on this study the experimental designing was prepared. As the design could be understood from the table below, from the given sample size, 30 grams, there was a percentage of share. Again the design was to understand the relationship of DE hydrant amount in sample with time attraction, cost of the sample and impacts on cockroach.

Boric acid

Boric acid is also called hydrogen borate, boracic acid, and orthoboric acid is a weak, monobasic Lewis acid of boron. However, some of its behavior towards some chemical reactions suggests it to be tribasic acid in Bronsted sense as well. Boric acid is often used as an antiseptic, insecticide, flame retardant, neutron absorber, or precursor to other chemical compounds. It has the chemical formulaH_3BO_3 (sometimes written $B(OH)_3$), and exists in the form of colorless crystals or a white powder that dissolves in water

Case1. Boric acid powder and peanut seed powder mixing

Table 4.Experimental design of boric acid

Case 1. Mixing of boric acid powder and peanut seed powder number	Boric acid powder amount %	Peanut Seed %	Filler, wheat flour %
1	-	100	
2	20	70	10
3	30	60	10
4	40	50	10
5	50	40	10
6	60	30	10
7	70	20	10
8	80	10	10
9	90	-	10

Silica gel

Silica gels characterized by being chemically inert, high surface area, high internal porosity, and strong adsorption capacity, widely used as dehumidifying desiccant, dehydrating agent, adsorbents, fillers and catalyst carrier. It is easy to adsorb polar substances, difficult to adsorb non-polar organic substances. Powder silica gel is perfect for drying and preserving flowers and bouquets. Silica gel powder, like all other silica gel formats will absorb moisture and hold it inside.

Case2. Silica gel powder and peanut seed powder mixing.

Table 5.Experimental design of silica gel

Number	Silica gel powder amount %	Peanut seed powder	Filler, wheat flour %
1	100	-	
2	90	-	10
3	80	10	10
4	70	20	10
5	60	30	10
6	50	40	10
7	40	50	10
8	30	60	10
9	20	70	10

3.2.4. Preparation of the sample

Firstly the sample 30 g with only attractant, and 30 g from only DE hydrant was prepared. Secondly 30 gram of sample from the mixing of peanut and boric acid, on one case by increasing boric acid , but decreasing the amount of attractant, peanut and another case increasing only the boric acid amount, and decreasing the peanut. From boric acid and peanut, 9 trials (sample) was made. Similarly 9 trials (maples) were prepared from the silica gel powder and peanut starting from preparation of sample from silica gel powder only and evaluating its individual impacts as well as the impact pattern if the silica gel increasing and decreasing with in the sample when the samples were prepared from the mixing of peanut as attractant and silica gel, dehydrant.

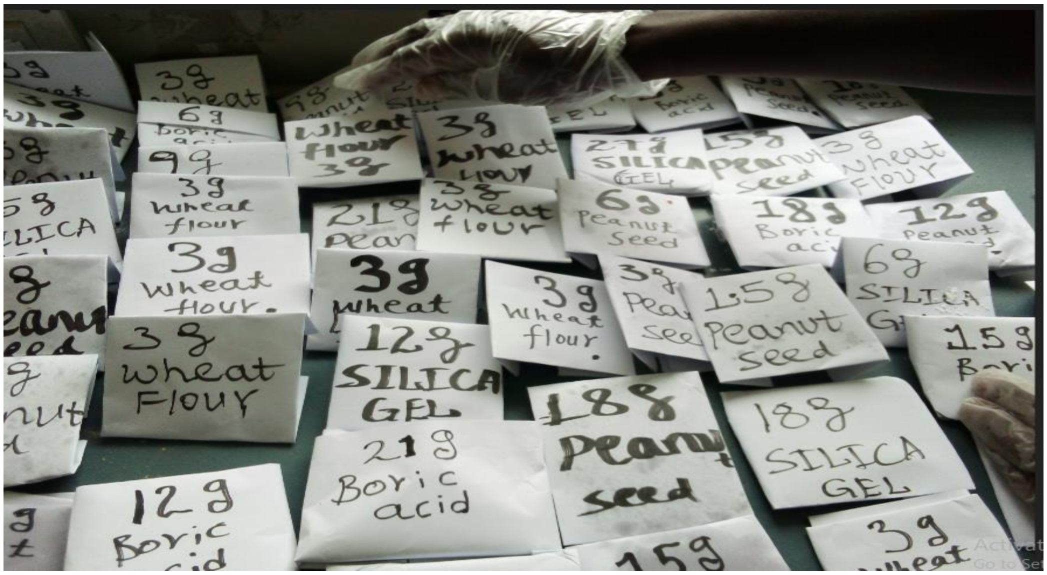


Figure11.Measured the sample of each ingredient

3.2.5. Collection of the cockroach

By using the insect net, the cockroaches were collected from different areas with much care. There were about 30 cockroaches collected by using insect net. Finally, the collected cockroaches were brought to work place.

Figure 12.cockroaches

3.2.6. Making the prepared sample on the hurdle.

The experiments performing area, hurdle, has had different division the sample was put at selected division, on10th, 9th , 8th , 7th ,6th, 5th, 4th , 3rd ,and 2nd division of the hurdle. The sample was attractant, DE hydrant and the mixture of the both made respectively.

3.2.7. Making of cockroach in hurdle and observation.

After the prepared sample was put on the selected division of the hurdle, the collected cockroaches were placed at the 1st hurdle of division. The cockroaches searched and had the sample had put at other division. After having that sample the cockroach could show some behaviour, then those behaviour was observed and recorded properly.

3.3. Recording of the data.

From the observation of the cockroach after it had the sample, the data was recorded numerical. This means the number cockroach which was disturbed by the sample, the disturbance was identified from the behavioural change on the cockroach, from its motion, loss of life. Further from this the attracting time of attractant was recorded. The impacts of attractant, peanut increment in the sample on attraction of the cockroach and also the relationship of dehydrant decreasing and increasing in the sample with the cockroach was recorded in order to know the pattern between the two.

CHAPTER FOUR: Results and Discussion

4.1. Characteristics of raw material

Raw material characterization plays an important part in the quality control process of product manufacture; Different analysis was carried out for determination of behaviour density, colour, odour, the texture, anti-cockroach properties, and particle size distribution in the samples. Laboratory material could be used for the study of the mentioned parameters respectively

4.1.1. DE hydrant

1. Boric acid

Boric acid, also called hydrogen borate, boracic acid, and ortho boric acid was known as weak, monobasic Lewis acid of boron. Boric acid crystals are white, odour less, and nearly tasteless. It looks like fine table salt in the granular form or like baby powder in the powdered form. Chemical reaction with environment in solid state was medium.

Table 6.The characteristics of Boric acid powder

Properties	Results.
Standard density	1400kg/m^3or1.4 g/cm^3
Color	White crystalline.
Texture	Approaches smooth.
Impacts on cockroach.	Dehydrating
Melting point	160-170 centigrade.
PH	8-10
dour	Odorless

2. Silica gel powder

Silica gels characterized by being chemically inert, high surface area, high internal porosity, and strong adsorption capacity, widely used as dehumidifying desiccant, dehydrating agent, adsorbents, fillers and catalyst carrier. It was known easy to adsorb polar substances, difficult to adsorb non-polar organic substances. Powder silica gel is perfect for drying and preserving flowers. Silica gel powder, like all other silica gel formats absorb moisture and hold it inside.

Table 7.The characteristics of silica gel powder

Properties	Results.
Standard density	2.21g/cm^3
Color	Blue
Texture	Rough before grinding
Impacts on cockroach.	Dehydrating agent/ dehumidifying.
Particle size	Fine.
Odors	Odorless

4.1.2. Attractant

1. **Peanut seed**: Peanut seed has served as a good attractant as a roaches are attracted to the food and they captured significantly more cockroaches

Table 8.Characteristics of peanut seed

Properties	Results.
Standard density	272Kg/m3
Color	Brown
Texture	Finny
Impacts on cockroach	Attracting.
Particle size	Fine.
Odor	Nutty odor
PH	6.8

4.1.3. Filler

1. Wheat

Wheat flour is a powder made from the grinding of wheat its density is 593kg/m^3 used for human consumption. Wheat varieties are called "soft" or "weak" if gluten content is low, and are called "hard" or "strong" if they have high gluten content. Hard flour, or bread flour, is high in gluten, with 12% to 14% gluten content, and its dough has elastic toughness that holds its shape well once baked. Soft flour is comparatively low in gluten and thus results in a loaf with a finer, crumbly texture. Soft flour is usually divided into cake flour, which is the lowest in gluten, and pastry flour, which has slightly more gluten than cake flour.

In terms of the parts of the grain (the grass fruit) used in flour—the endosperm or protein/starchy part, the germ or protein/fat/vitamin-rich part, and the bran or fiber part—there are three general types of flour. White flour is made from the endosperm only. Brown flour includes some of the grain's germ and bran, while whole grain or wholemeal flour is made from the entire grain, including the bran, endosperm, and germ. Germ flour is made from the endosperm and germ, excluding the bran.

The Results and Discussion sections are the "agreement" of most engineering reports. The role that they play in a lab report is obvious; in other types of reports, they can fulfill different purposes. In a design report, the results and discussion may involve an evaluation of the design or method used. In a feasibility or case study, the results and discussion section would involve measuring the feasibility or evaluating the success of one or more solutions. Therefore, we had the results of the characterization of raw materials, the product mixing ratio, the impacts of each sample on cockroach and also cost of each sample. The detail results provided in the tables bellows

Case1. Mixing of boric acid powder and peanut seed powder.

Table 9.Results of boric acid

Number	Boric acid powder amount %	Cost in ETB.	Peanut seed powder%	Cost in ETB.	Filler, wheat flour %	Cost in ETB	Time(min) interval of attraction unit	Number of cockroach was…	Cost at sample scale ETB.
1	-		100	1.70			30	8	1.70
2	20	1.40	70	1.2	10	0.15	35	7	2.75
3	30	2.20	60	1.00	10	0.15	39	6	3.35
4	40	2.90	50	0.80	10	0.15	45	6	3.85
5	50	3.60	40	0.70	10	0.15	51	5	4.45
6	60	4.30	30	0.50	10	0.15	57	7	4.95
7	70	5.00	20	0.34	10	0.15	60	6	5.49
8	80	5.70	10	0.17	10	0.15	67	5	5.92
9	90	6.50	5	0.09	5	0.15	60	2	6.7

As it shown with in the table the time interval of attraction increases the amount of boric acid increases this indicates that the active ingredient boric acid has no significant attraction impact on the cockroach. The number of cockroach in the case of only boric acid was a few but the killing intensity was increasing as the boric acid increased .The cost relation with in the above table is increased as the amount of boric acid powder increased with in each sample. In short from the table result, we could summarize that the boric acid amount and the number of cockroach being attracted were inversely related, but for cockroach died and tired, the boric acid powder amount in the sample was directly related.

In addition to these relations, the boric acid powder amount in a sample and the cost has also relation that the amount of boric acid increased with in the sample the cost of sample became increase, direct relationship since the boric acid is cost.

Furthermore the constant amount of the filler within the sample has good importance because the wheat flour, filler, is available and easily usable again it has great contribution on decrement of the cost. Finaly from this specific table result the product which the advisable in all aspects such as cost, attraction time, the impact which the sample made on the cockroach is at 6th number sample among the 9 sample .In another word the 60 % boric acid powder, 30% peanut seed powder and the remaining 10 % wheat flour could be the optimum.

Figure 13.effect of boric acid &peanut seed powder mixture on cockroach

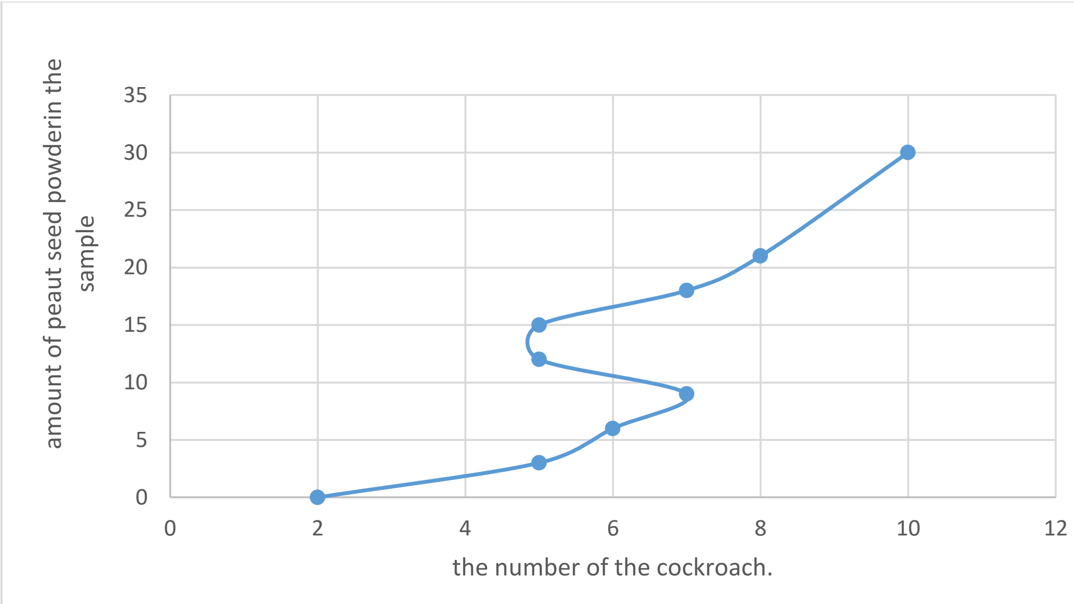


Figure 14.Number of cockroach vs. amount of peanut seed in the sample

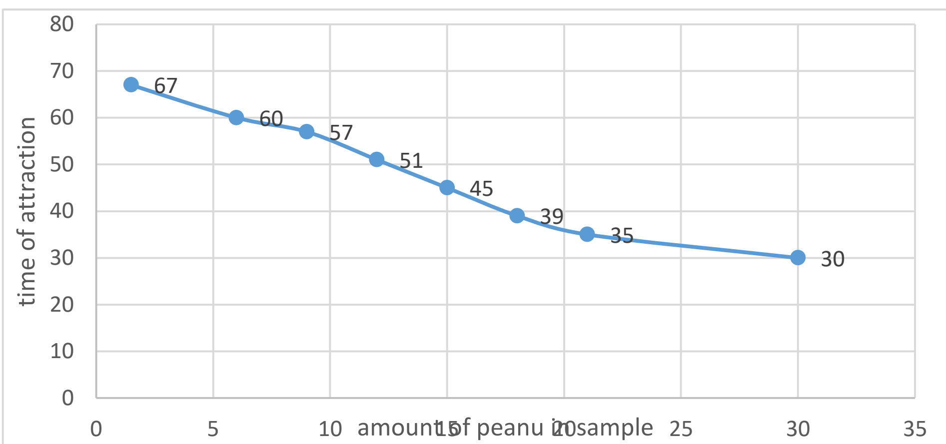


Figure 15.Amount of peanut in the sample vs. time of attraction

Case2. Silica gel powder and peanut seed powder mixing.

Table 10.Results of silica gel &peanut seed powder mixture

Number	Silica gel powder amount %	Cost in ETB.	Peanut seed powder%	Cost in ETB.	Filler, wheat flour %	Cost in ETB.	Time interval of attraction unit.	Number of cockroach was…	Cost at sample scale ETB.
1	100	4.74	-				50	-	4.70
2	90	4.26	-		10	0.15	41	1	4.41
3	80	3.80	10	0.17	10	0.15	33	2	4.02
4	70	3.32	20	0.34	10	0.15	22	4	3.81
5	60	2.84	30	0.50	10	0.15	17	3	3.49
6	50	2.37	40	0.70	10	0.15	12	6	3.22
7	40	1.90	50	0.80	10	0.15	20	5	2.85
8	30	1.42	60	1.00	10	0.15	19	6	2.57
9	20	0.95	70	1.20	10	0.15	17	7	2.30

As it shown with in the table the time interval of attraction increases the amount of silica gel powder increases this indicates that the active ingredient silica gel powder had little attraction impact on the cockroach. The number of cockroach in the case of only silica gel powder was a few but the killing intensity was increasing as the silica gel increased .The cost relation with in the above table is increased as the amount of silica gel powder increased with in each sample. In short from the table result, we could summarize the result that the silica gel amount and the number of cockroach being attracted were inversely related, but for cockroach died the silica gel powder amount in the sample was directly related. In addition to these relations, the silica gel powder amount in a sample and the cost has also relation that the amount of silica gel increased with in the sample the cost of sample became increase, direct relationship since the silica gel is cost and very important in other many industries.

Furthermore the constant amount of the filler within the sample has good importance because the wheat flour, filler, is available and easily usable again it has great contribution on decrement of the cost. Finally from this specific table result the product which the advisable in all aspects such as cost, attraction time, the impact which the sample made on the cockroach is at 9th number sample among the 9 sample .In another word the 20% silica gel powder, 70% peanut seed and the remaining 10 % wheat flour could be advisable.

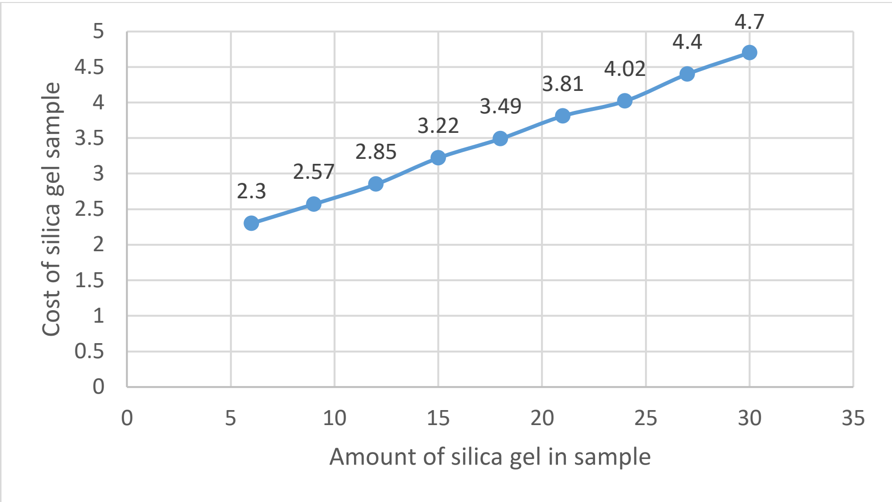


Figure 16.Cost vs. silica gel

which means the increasing of silica gel can increase the unity cost of the production because the unity cost can be from variable cost, like silica gel amount and fixed cost.

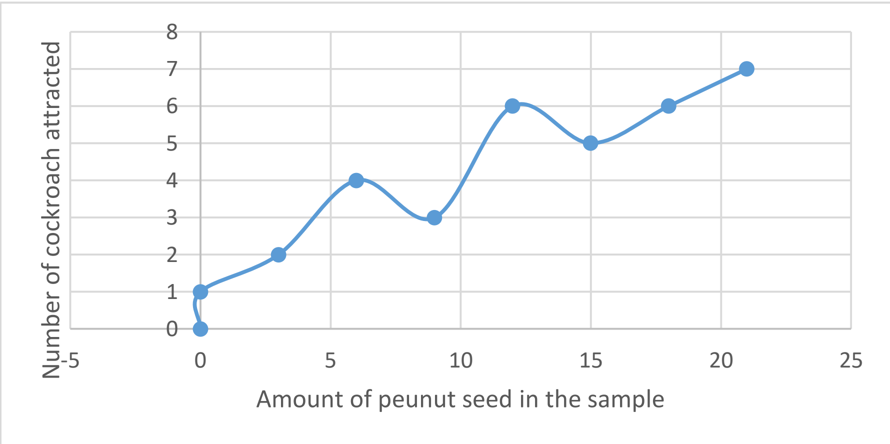


Figure 17.Number of cockroaches attracted vs. amount of peanut seed in the sample

Comparing and contrasting of the result with the standard result.

Table 11.Comparing and contrasting of the result with the standard result

	Boric acid		Silica gel	
Aspects	Experimental sample.	Standard	experimental sample	Standard
Time of attraction	57 minutes	60 minutes	19 Minutes	18 Minutes
Impacts on cockroach	Relatively more	Slightly less	Relatively more	Relatively more

Observation:

We have got a number of the cockroach from wolkite university lounge, all they were brown in color and small and large in size, found always some hidden or not naked areas such as under the bed, in some electronic device ports and etc. The catching of the cockroach was difficult since it is speedy after knows the appearance of the person. After the cockroach brought to the experimental area it disturbed four about a minutes (30_40) the become into it natural behavior. We observed cockroach which adopt wild life and did no interested in searching something in home. Those were large in size, brown and highly speedy and available around moisture areas.

CHAPTER FIVE: Material balance

5.1. Material balance for anti-cockroach powder Production

Basis:

- 300 working day/year
- 4 batch/day; 4 hours for one batch

Amount of wheat flour per year =30000 kg/year

- ✓ Amount wheat flour per Bach $=\frac{30000\ \text{kg/year}}{\frac{300day}{year}*4batch}=25$ kg/Bach

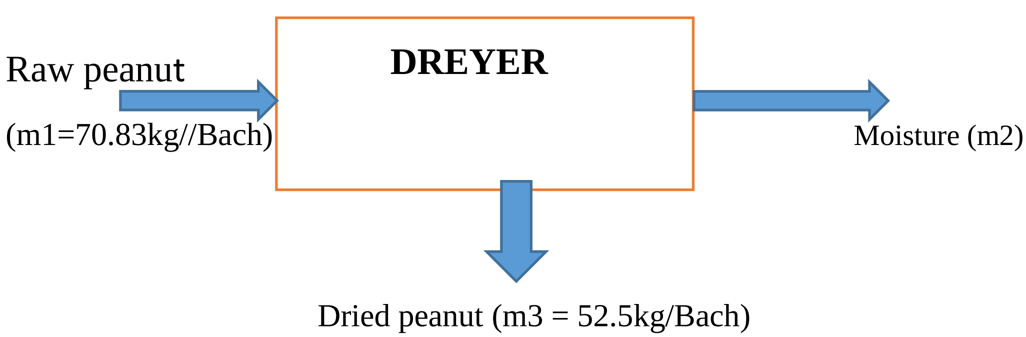
Amount of needed peanut per year =85000 kg/year

- ✓ Amount of needed peanut per Bach $=\frac{85000\ \text{kg/year}}{\frac{300day}{year}*4batch}$ =70.83kg/Bach

Amount of needed boric acid per year =90,000 kg/year

- ✓ Amount of silica gel needed per batch$=\frac{90{,}000\ \text{kg/year}}{\frac{300day}{year}*4batch}$ =75kg/Bach
- ✓ Density of peanut=272kg/m3
- ✓ Density of silica gel=2210kg/m3
- ✓ Density of wheat flour=593kg/m3

1. **Material balance on dryer**



Mass in + generation=mass out + consumption+ accumulation

Mass in=mass out

M1=m2+m3

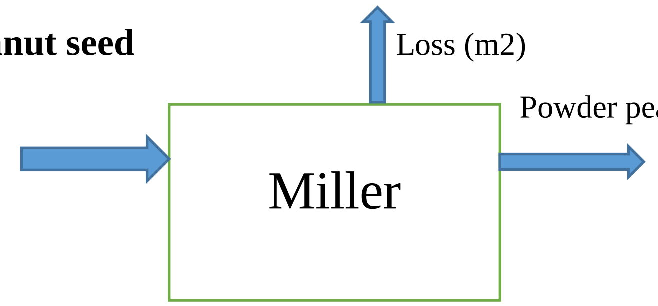
70.83kg/Bach=m2+52.5kg/Bach   M2=18.33kg/Bach

2. Milling of peanut seed

Loss (m2)

Powder peanut (m3) Dry peanut

(m1= 52.5kg/Bach



Let assume the miller has ability or efficiency of milling is 95%since there is no reaction,

Input =output; but the efficiency of miller is 95 %

Input efficiency = output = m3

52.5kg/Bach * 0.95 =49.875 kg/Bach   m2=52.5kg/Bach - 49.875 kg/Bach = 2.625kg/batch

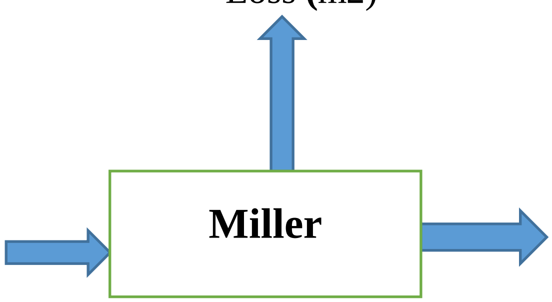
Therefore, the milled of peanut seed removed from miller is = 49.875 kg/Bach

3. Milling of silica gel

Loss (m2)

Boric acid beachy

(m1=75kg/Bach)



powder boric acid

(m3)

Let assume the miller has ability or efficiency of milling is 95%. Since there is no reaction,

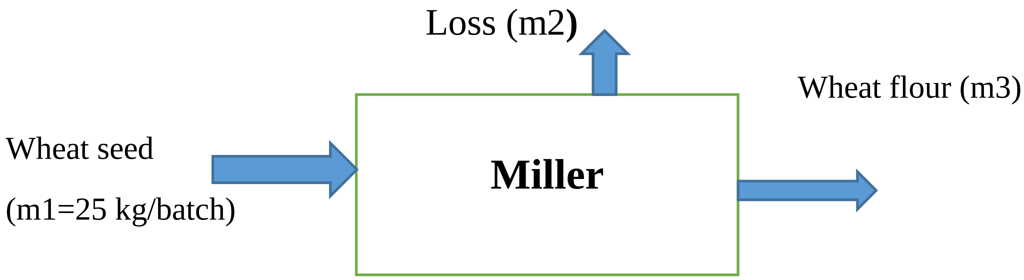
Input =output; but the efficiency of miller is 95 %

Input efficiency = output = m3

75 kg/Bach * 0.95 = 71.25kg/Bach

Therefore, the milled silica gel powder from miller is = 71.25 kg/Bach

3. Milling of wheat seed



Let assume the miller has ability or efficiency of miller is 95%. Since there is no reaction,

Input =output; but the efficiency of miller is 95 %

Input efficiency = output = m3

25 kg/Bach * 0.95 = 23.75kg/Bach

Therefore, the milled wheat seed removed from miller is = 23.75 kg/Bach

4, Mixing

Mass in= Mass out

m1+m2+m3=m4

49.875+71.25+23.75=144.8755kg/Bach

144.8755kg/Bach of anti-cockroach is produced for one batch.

5.1.1. Equipment Sizing

A. Sizing of silica gel storage tank

$V=\frac{m}{ps}$

$=\frac{90000kg}{2210kg/m^3}= 40.7m^3$

b. Sizing of peanut storage tank

$v=\frac{m}{pp}$

$=\frac{85000\text{ kg}}{272\text{kg}/m^3}= 312\ m^3$

CHAPTER SIX: Economic Analysis

This project aims to present a manufacturing system that is capable of operating under conditions that has a potential to generate profit. As a necessity the economic viability of this manufacturing plant must be addressed considering the society and government with which it will operate. The primary concern of an investor lies in the rate of return (ROR) based on accurate cost estimates and sound data. Since the profit equals total income minus all expenses, it is essential that all the costs involved in manufacturing processes are considered. A capital investment is required for any industrial process and determination of the process consists of fixed capital investment of physical equipment and facilities in the plant plus necessary investment is an important part design project. The total investment for any working capital which must be available to pay salaries, keep raw materials and products on hand and handle other special items requiring a direct cash outlay. Using payback period, rate of return and unit product cost a profitability analysis will be conducted to see the viability of this plant design.

Basis of economic analysis:

- ✓ Plant operation:
- ✓ 2 shifts per day
- ✓ Batch Process
- ✓ Plant life: 10 years ,MAR=12%
- ✓ Plant production rate: ant-cockroach powder production capacity = 200,000kg/year

6.1. Equipment's cost

The installation of equipment involves costs of labour, foundations, supports, platforms, construction expenses and other factors that directly take part on the erection of purchased equipment. There in general is the range of installation cost as a percentage of the purchased equipment cost for various types of equipment's. Installation labour cost as a function of equipment size shows wide Variations when scaled from previous installation estimates. Table shows exponents varying selected pieces of equipment.

Table 12.Some equipment cost

NO	Equipment	parameter	Size(m3)	Quantity Y	Construction n of Material	Unit Cost (ETB)	Total cost(ETB)
1	Storage tank of silica	Volume	40.7	2	Carbon Steel	1,298,000	2,596,000
2	Miller	Volume	13	2	stainless steel	1,177,444. 75	2,254,889 .5
3	Mixer	Volume	30	2	stainless steel	2 321,200	4,642,400
4	Pump	Flow Rate	15m3/hr	2	stainless steel	231,000	462,000
5	Conveyor	Power	6hp	2	Carbon Steel	1,320,000	2,640,000
6	Aging tank	Volume	50	1	stainless steel	707,498.4	707.494.4
7	Package	Volume	576		Plastic bug	660,000	660,000
8	Total purchased equipment cost						13,9627,83.9

Source: www. Matches/equipment cost. Com

6.2. Fixed capital investment estimation

Capital investment is the total amount of money needed to supply the necessary plant and Manufacturing facilities plus the amount of money required as working capital for the operation of facilities. This project considers the proportional costs of each major component of fixed capital investment as outlined below determination technique of the cost factors presented here are based on a careful study and associates plus additional data and interpretations from other More recent sources$ with input based on modern industrial experience , then selected 40%fixed capital investment for equipment cost (MAX S. PETERS. 1991).

6.2.1. Fixed capital investment values for direct and indirect cost

A) Direct cost (DC)

Direct cost is the type of fixed capital investment costs that directly applicable for plant erect. It takes 70-85% of FCI range. We can used for calculation, 82% is available for this project.

1). Instrumentation and control

Instrument cost, installation-labor cost and expenses of auxiliary equipment and materials constitute the major portion of the capital investment required for instrumentation. Instrumentation and control, installed (25-55% of purchased equipment cost). This component is estimated to be 30% of purchased equipment cost for solid -fluid chemical process plant.

2). Piping cost

This refers to the cost for raw material, intermediate product, finished product, water, and waste products piping. Items involved in the complete erection of all piping used directly in the process which include the labour, valves, fittings, pipe, support. Piping installed (25-35% of purchased equipment cost). The piping cost is estimated to be 32% 0f purchased equipment cost.

3) Cost of electrical system

The electrical system consists of the power wiring, lighting, transformation and services, instrument and control wiring. Electrical, installed (10-15% of purchased equipment cost). This component is estimated to be 12% of purchased equipment cost for solid-fluid chemical process plant.

4). Cost of buildings and Auxiliary

The cost involved in the erection of all buildings connected with the plant (labour, materials and supplies). Buildings process and auxiliary (20-30% of purchased equipment cost). Cost of plumbing, heating, lighting, ventilation, and similar building services are included here. This component is estimated to be 23% of purchased equipment cost for solid fluid chemical process plant (MAX S. PETERS. 1991).

5). Cost of yard improvement

This involves costs for fencing, grading, roads, sidewalks, rail road sidings, landscaping and similar items. Yard improvement (10-20% of purchased equipment), Yard improvement cost for chemical plant is estimated to be 12% of purchased equipment cost.

6). Service facility and utility cost

Utilities for supplying steam, water, power and fuel are part of the service facilities of a chemical process plant. Services facilities (30-80% of purchased equipment cost), Services include the cost of waste disposal, fire protection, and miscellaneous service items (shop, first aid, cafeteria equipment etc.). This component is estimated to be 65% of the purchased equipment cost for Solid fluid chemical process plant (MAX S. PETERS. 1991).

7). Cost of land

The plant will be sited at wolkite in the Southern part of Ethiopia. The cost of land (4-8% of purchased equipment cost), this component is estimated to be 7% of the purchased equipment cost. The component of direct cost listed table with range and selected percentage.

Table 13.Direct cost

NO	Direct cost Component	Assumed (%) of equipment cost (ETB)	Cost (%)
1	Total purchased equipment	100 E	13,962,783.9
2	Purchased equipment Installation	39E	54,454,85.72
3	Instrumentation and control	30E	41,888,35.17
4	Piping installed	32E	44,680,90.84
5	Electrical installed	12E	16,755,34.06
6	Building including service	23E	32,114,40.29
7	Yard improvement	12E	16,755,34.06
8	Service facilities	65E	90,075,809.535
9	Land	6E	83,776,70.34
10	Total direct cost		962,470,547.6

B) **Indirect cost**

1). Engineering and supervision cost

This involves construction design and engineering, drafting, purchasing accounting, construction and cost engineering, travel, reproductions, communications and home office expenses including overhead. Engineering and supervision (5-30% of E). This component is estimated as 15% of purchased equipment cost.

2). Construction expenses

This component involves construction and operation, construction tools and rentals, construction payroll, taxes, insurance and other overheads. Construction expenses(15% of E). This component is estimated as 34% of purchased equipment cost.

Table 14 .Indirect cost

NO	Indirect cost Component	Assumed% of equipment cost	Cost (ETB)
1	Engineering and Supervision	15E	2094417.59
2	Construction Expense	34E	4747346.526
3	Total indirect cost		6841764.1

Therefore,

Fixed capital investment cost (FCI) = DC + ID FCI

= 13,962,783.9+6841764.1 = 20804548.01ETB

The total capital investment = Fixed Capital investment + working capital investment.

In most plants working capital investment takes (10-20) % of total capital investment. In this plant, it is assumed that 15% of total capital investment cost.

Therefore, Total capital investment = fixed capital investment + working capital investment

TCI = FCI + WCI…………………………………….Eq1

WCI= 15%TCI………………………………………..Eq2

Substitute equation 2 in to equation 1

TCI = FCI + 0.15TCI

= 20804548.01ETB + 0.15TCI

TCI= $\frac{20804548.01}{0.85}$=24,475,738.8EB

TCI=24,475,738.8EB

6.3. Total product cost estimation

Determination of the necessary capital investment is only one part of a complete cost estimate. Another equally important part is the estimation of costs for operating the plant and selling the Products. These costs can be grouped under the general heading of total product cost. The latter, in turn, is generally divided into the categories of manufacturing costs and general expenses. Manufacturing costs are also known as operating or production costs. Further subdivision of the Manufacturing costs is somewhat dependent upon the interpretation of direct and indirect costs.

Total product cost = manufacturing cost + general expense

Manufacturing cost = direct production cost + fixed charge + plant-overhead cost

6.3.1. Raw material cost

In the industry, one of the major costs in a production operation is for the raw materials involved in the process. The amount of the raw materials which must be supplied per unit of time.

Table 15 .Raw material cost with transportation

NO	Raw material	Mass Kg/year	Unit price ETB/kg	Total price (ETB)
1	SILICA GEL	90,000	270	24300000
2	PEANUT SEED	85,000	80	6800000
3	WHEAT FLOUR	30,000	20	600000
4				31,700,000

Depreciation (10% of FCI) = 2080454.8ETB 6.3.2. Fixed charges

Local taxes (3-4%of FCI) assume 3% = 624136.44ETB

Insurance (0.4-1% of FCI) assume 1% = 208045.48ETB

Total fixed charges = 2912636.72ETB

Total fixed charges = 15% of total product cost (TPC)

$$TPC=\frac{\text{Total fixed charges}}{0.15}$$

TPC = 19417578.13ETB

6.4. Operating Labour

It is the sum of direct and indirect Labour Costs (DLC and ILC)

Table 16 .Direct labour cost (DLC)

Staff	Quantity	Annual salary per Month ETB	Total Annual Salary , ETB
Plant manager	1	10000	120000
Production manager	1	9500	114000
Chemical engineer	4	8000	96000
Mechanical engineer	3	8000	96000
Electrical engineer	2	8000	96000
Quality assurance Manager	2	9000	108000
Supervisors	2	10,000	120000
Lab Technicians	6	7000	84000
Plant site worker	5	4500	54000
TOTAL			88,8000

Table 17 .Indirect cost (ILC)

Staff	Quantity	Monthly salary Unit salary (birr)	Total Annual Salary, ETB
Managing director	1	10,000	300000
Human resource Manager	1	8,000	2400000
Sales manager	1	6500	1950000
Accountant	3	4500	1350000
Store keeper	5	4000	1200000
Receptionist and Secretary	1	3800	1140000
Cleaner	4	3000	900000
Driver	5	4000	1200000

Security men	8	3600	1080000
Total			11,520,000

Total Labour cost =TDLC +TILC

Total operating labour cost = 88,8000+11,520,000

Total operating labour (OL) = 12,408,000ETB

6.5. Direct production cost

- ✓ Raw material Cost 31,700,000ETB
- ✓ Direct supervisory and electric labour (10-25% of OL) assume 12% =2481600ETB.
- ✓ Utilities (10-20% of TPC) assume 15% = 2912636.7ETB
- ✓ Maintenance (2-10% 0f FCI) assume 4% = 832181.9ETB
- ✓ Operating supplies (OS) (10-20% of maintenance) assume 15% = 124827.2ETB
- ✓ Laboratory charges (10-20% of OL) assume 14% =17,371,20ETB
- ✓ Patents and royalties (0-6% of TPC) assume 4% = 776703.12ETB
- ✓ Plant overhead cost (5-15% of TPC) assumes 9% = 1747582ETB
- ✓ Direct production cost = 962,470,547.6ETB
- ✓ Manufacturing cost = fixed charges + direct production costs + plant overheads
- ✓ Manufacturing costs = 2912636.72ETB+962,470,547.6ETB+1747582ETB
- ✓ Manufacturing cost = 967130766.3ETB

6.6. General expense

General expense = administrative cost + distribution and selling costs + research and development costs + interest

- ✓ Administrative cost (2-6% of TPC) assumes 4% = 9,726,445.828ETB
- ✓ Distribution and selling costs (2-20% of TPC) assume 12% = 29,179,337.48ETB
- ✓ Research and development cost (5% of TPC) = 970878.9ETB
- ✓ Interest (0-10% of TCI) assumes 6% = 1468544.3ETB
- ✓ General expense = 41345206ETB
- ✓ Total expense = manufacturing cost + general expense
- ✓ Total expense = 967130766.3ETB + 41345206 ETB
- ✓ Total expense = 1008475972ETB

6.7. Project evaluation

In this part the profitability of the plant is evaluated by finding the profit of the factory obtains from the sale of anti-cockroach powder. From the plant capacity that we decide the annual production

BASIS

Let the tax rate be 34%

Rate of the plant is 200,000 kg/year at the full capacity.

Total selling price = total production* unit price = 200,000 kg/year *500birr /kg

Total selling price =100,000,000ETB

Net profit=gross income*(1-tax rate)

- ✓ gross income =Total selling-TPC

=1000000000EB-19417578.13EB= 980582421EB

Net profit=980582421EB *(1-0.34) = 6507845.5EB

6.8. Rate on investment (ROI)

$$\text{ROI}=\frac{\text{Net profit}}{\text{TCI}}\text{x}100$$

$$=\frac{6507845.5\text{EB}}{24,475,738.8\text{EB}}\text{x}100= 0.265\text{x}100$$

$$=26.5\%$$

When the rate on investment is greater than the minimum acceptable rate since the project is feasible.

6.9. Break-even analysis

The break-even analysis establishes a relationship between operation costs and revenues. It indicates the level at which costs and revenue are in equilibrium. To this end, the break-even point of the project including cost of finance when it starts to operate at full capacity is estimated by using income statement projection.

- ✓ Variable cot(v) = raw material cost + utility cost

= 31,700,000 + 2912636.7ETB

=34612636.7ETB

Fixed cot = TPC –V c = 49417578.13-34612636.7ETB

= 15195058.57ETB

6.10. Payback period calculation

Project life is assumed 10 years and we use straight line method

VS = Salvage value of the property at end of service life assume that zero.

$$PBP = \frac{\text{total fixed capital investment} - \text{salvage value}}{\text{net profit} - \text{depriciation}}$$

$$= \frac{20804548.01\text{EB}}{9860372\text{EB} - 2080454.8\text{EB}}$$

PBP = 2year; since the payback period is < 5 years, then the project is feasible

Payback Period Reference (PBPREFF):-

The ratio of FCI to TCI= $\frac{20804548.01EB}{24475738.8EB}$

=0.85

$$\text{PBP ref} = \frac{\text{The ratio of FCI to TCI}}{\text{MAR+ The ratio of FCI to TCI/N}}$$

$$= \frac{0.85}{0.12+0.85/10} \qquad N=10$$

= 4.15

This implies, the project is feasible because PBP is less than PBP reff. I.e. 2 year < 4.15 year.

CHAPTER SEVEN: plant siting and location

The geographical location of the final plant can have a strong influence on the success of an industrial venture. An approximate idea as to the plant location should be obtained before a design project reaches the detailed estimate design. The choice of the final site should first be based on a complete survey of the advantages and disadvantages of various geographical areas and ultimately on the advantages and disadvantages of available real estate. The following factors should be considered in choosing a plant site.

Raw Materials

- Market
- Power and fuel
- Climate
- Transportation facilities
- Water supply
- Waste disposal
- Labour supply
- Taxation and legal restrictions
- Site characteristics
- Flood and fire protection
- Community factors

a) Raw Materials

Availability the source of raw materials is one of the most important factors influencing the selection of a plant site. This is particularly true for the anti-cockroach powder production plant because a large volume of raw material is consumed in the process, which will result in the reduction of the transportation and storage charges. The raw material for the production of the anti-cockroach powder in this case is silica gel and peanut seed thus the availability is directly related to the location.

b) Location

The location of markets or intermediate distribution centres affects the cost of product distribution and time required for shipping. Proximity to the major markets is an important consideration in the selection of the plant site, because the buyer usually finds advantageous to purchase from near-by sources. The largest market for anti-cockroach powder is the capital city so the plant should be near it.

c) Availability of Suitable Land

The characteristics of the land at the proposed plant site should be examined carefully. The topography of the tract of land structure must be considered, since either or both may have a pronounced effect on the construction costs. The cost of the land is important, as well as local building costs and living conditions. Future changes may make it desirable or necessary to expand the plant facilities. The land should be ideally flat, well drained and have load -bearing characteristics. A full site evaluation should be made to determine the need for piling or other special foundations. The suitable land for the trees is the ideal near the capital close to wood processing the industries.

d) Transport

The transport of materials and products to and from plant will be an overriding consideration in site selection. If practicable, a site should be selected so that it is close to at least two major forms of transport: road, rail, waterway or a seaport. Road transport is being increasingly used, and is suitable for local distribution from a central warehouse. The c cheapest and most available mode of transport is trucks.

e) Availability of Labours

Labours will be needed for construction of the plant and its operation. Skilled construction workers will usually be brought in from outside the site, but there should be an adequate pool of unskilled labours available locally; and labours suitable for training to operate the plant. Skilled tradesmen will be needed for plant maintenance. Local trade union customs and restrictive practices will have to be considered when assessing the availability and suitability of the labours for recruitment and training.

e) Availability of Utilities

The word "utilities" is generally used for the ancillary services needed in the operation of any production process. These services will normally be supplied from a central facility and includes Water, Fuel and Electricity which are briefly described as follows:

Water: - The water is required for large industrial as well as general purposes, starting with water for cooling and washing. The plant therefore must be located where a dependable water supply is available namely lakes, rivers, wells, seas. If the water supply shows seasonal fluctuations, its desirable to construct a reservoir or to drill several standby wells. The temperature, mineral content, slit and sand content, bacteriological content, and cost for supply and purification treatment must also be considered when choosing a water supply.

f) Environmental Impact and Effluent Disposal

Facilities must be provided for the effective disposal of the effluent without any public nuisance. In choosing a plant site, the permissible tolerance levels for various effluents should be considered and attention should be given to potential requirements for additional waste treatment facilities. As all industrial processes produce waste products, full consideration must be given to the difficulties and coat of their disposal. The disposal of toxic and harmful effluents will be covered by local regulations, and the appropriate authorities must be consulted during the initial site survey to determine the standards that must be met. Anti-cockroach powder manufacturing industries usually have tolerable effluents considered negligible.

h) Local Community Considerations

The proposed plant must fit in with and be acceptable to the local community. Full consideration must be given to the safe location of the plant so that it does not impose a significant additional risk to the community.

i) Climate

Adverse climatic conditions at site will increase costs. Extremes of low temperatures will require the provision of additional insulation and special heating for equipment and piping. Similarly, excessive humidity and hot temperatures pose serious problems and must be considered for selecting a site for the plant. Stronger structures will be needed at locations subject to high wind loads or earthquakes. Finally, due to the above criteria's our plant location will be implemented in wolkite area, near to raw material import areas.

CHAPTER EIGHT: Conclusion and Recommendation.

8.1. Conclusion

As we could know form different sources different kind of cockroach preventing method have be discovered and also they have been used. Our study focused on the production of ant-cockroach powder at optimum point in term of time of attraction, cost of product and impact on cockroach by having comparison between the selected active ingredient and attractant. From this study one thing possible to conclude that the silica gel powder with peanut seed at optimum point, where 20% of silica gel powder and 70% of peanut seed powder and 10% with the filler, wheat flour became more effective and efficient. The boric acid powder also has very great dehydrating impacts with different points of mixing ratio. Relatively in all aspects, time of attraction, cost of the sample and the impacts on the cockroach, silica gel powder and peanut seed powder mixture more than boric acid and peanut seed powder mixture.

8.2. Recommendation

Taking long time for experiment is needed because the interval of time that needed for cockroach in order to come the sample takes the long time, it may take minutes even an hours for one sample. Collecting the cockroach carefully has great role for the experiment in time interval that needed for one sample since if the cockroach not collected carefully it cannot behave normal, disturb, as the result experimental time needed for one sample become more. Studying the cockroach in its sex (male and female) cockroach give relatively different responses for the same sample and also the different species has also difference with different metamorphic stage. Well organized laboratory work is necessary to determine the quality parameter of Anti cockroach powder produced from boric acid,

there is the need for further research to ascertain the shelf life of the anti-cockroach powder before attempting to produce on large scale.

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APPENDIX

A- Laboratory equipment and samples photos

Silica & Boric acid


wheat flour

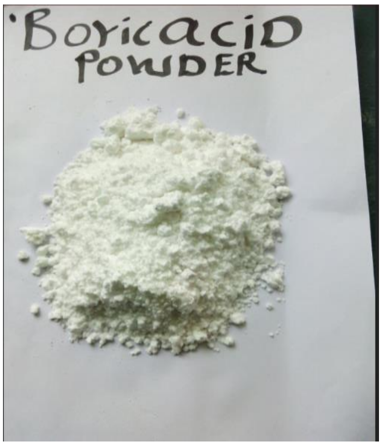
silica gel solid


Wet Peanut

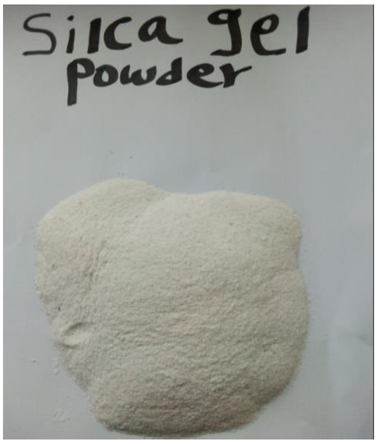
size reducer

boric acid size reducing

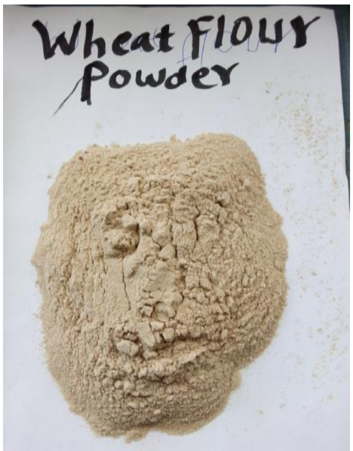
Silica gel, boric acid & flour

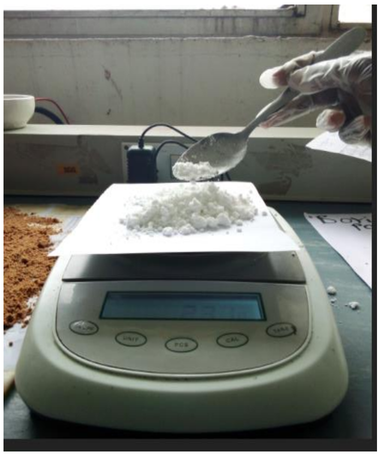


Boric acid powder



silica gel powder





Wheat flour powder peanut seed powder Boric acid powder measuring

21 g Boric acid powder sample Peanut seed powder measuring

All raw material (boric acid powder, silica gel powder, wheat flour powder &peanut seed powder) measured sample