OPTIMIZATION OF SOME PARAMETERS USING POTASSIUM HYDROXIDE (KOH) ON CASSAVA PEELING

BY

JONAH PETER

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(B. Eng)

IN

CHEMICAL ENGINEERING

OCTOBER 2008

DECLERATION

I JONAH PETER with registration number 2003/15021EH declare that the research project report is my original work and has not been presented elsewhere to the best of my knowledge

Name ....

Sign ....

CERTIFICATION

The research project work by JONAH PETER has been examined and certified under the supervision of Dr Duncan Aloko to be adequate in scope and publicity for the partial fulfillment of the requirement for the award of bachelor degree in engineering (B. Eng) in chemical engineering.

.... 30-10-2008........................

Dr Duncan Aloko Date

Project Supervisor

....

Dr M.O Edoga Date

Head of Department

.... 15/11/2008..............................

External Supervisor Date

DEDICATION

This project is dedicated GOD Almighty, to my mother Mrs. Sarah Peter and my father His Royal Highness Mr. Peter M Garba whom love I cannot forget.

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My sincere thanks goes to almighty GOD who despite all odd made life worth living. I wish to express my profound gratitude to my supervisor Dr Duncan Aloko for his numerous advice and encouragement during the course of this project. Also in this respect my special thanks goes to my head of department Dr M.O Edoga and other staffs of chemical engineering department.

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My mother Mrs. Sarah Peter and my sisters for their moral and financial support all through this point of life.

ASTRACT

The optimization of some parameters using KOH on cassava peeling has been successful carried out, the research work covered both contour and surface plot from computer soft wear (mini tab) with coded unit. The process flow sheet of these research shows the major route used in optimizing these parameters to achieved the aim of the research.

The economic evaluation of this research shows that the optimization of these parameters will improve the economic growth of developed countries that engaged in the production of cassava in large quantity, and it will also improved the revenue of these country as well as reduce the man power used in peeling the outer cortex as it is used world wide.

The un usual behavior of weight notice in analyzing these result in computer soft wear can also be do away with since there is a successful plot of both the contour and surface graph.

The significant P-value or α-value obtain in this analysis is 0.05; any value greater than this is regarded as insignificant and can be avoided.

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CHAPTER ONE

1.0 INTRODUCTION

The project title optimization of some parameter using potassium hydroxide (KOH) on cassava peeling is hereby introduced under the following items

1.1 Background of Study

Cassava scientifically called (manihot esculenta) is an important economic crop cultivated in many part of the world most especially in the tropical region such as Brazil, India, and several West African countries including Nigeria. The plant is classified into perennial shrub due to it characteristic and high energy source, it's also a rich root carbohydrate crop which can be process into wide variety of food to industrial starches which makes it important economically. Cassava Wikipedia (free encyclopedia)

cassava which contain starch .cyanide, ethanol and served as source of food for human consumption can be process into different ways to achieved one objective, ranging from steaming, roasting, boiling and fermenting. in most African country including Nigeria cassava can be process into different variety of food such as fufu from Nigeria ,Chikwangue from central African republic and Ntuku from democratic republic of Congo. Due to it toxic substance which it contain, cassava soaked in water for two to three days will result in the removal of cyanide. (Akinrele I.A 1986.)

cassava which is also called yucca is a woody shrub of the (spurge family) native of south America, that is extensively cultivated as an annual crop in tropical and sub tropical region for it edible starchy tuberous roots, a major source of carbohydrate, indeed is the largest source of carbohydrate for human consumption in the world with African as it largest center of production. (Cassava production and utilization in Africa FIRRO)

1.2 Approach

Optimization of some parameter using potassium hydroxide to peel cassava is a scientific method of peeling cassava where parameter such as temperature, concentration and contact time will be varies in interval of time using second order factorial method to achieve the aim of the study. The weight of the cassava will be determined before and after the experiment using a weighing balance thereby immersing the root into a big jar containing 100ml of potassium hydroxide (KOH). The mixture will be heated for an interval of time using a heating device and the corresponding temperature will be taken with the aid of a thermometer. The final weight of the cassava will determine if the cassava is peel effectively and efficiently.

1.3 Problem Statement

Since the inception of cassava which was first cultivated in central Brazil where it is likely first domesticated not more than 10000 years Bc. (cassava free encyclopedia) an engineering approach has been carried out, where research on scientific and engineering method to which the outer cortex which is corky can be peel to let assets to the inner fleshy part which can be processed into various edible carbohydrate and industrial starches, other than the traditional method of using knives, but less or no emphasis as to other scientific and engineering approach to enhance this research has been put in place .this project work aim to enhance this research by optimizing some parameters such as concentration, temperature and contact time using potassium hydroxide (KOH) to peel the cortex part so as to have easy and quick assets to the inner part that will be process into various edible food and industrial starches for commercial used. A second order factorial method will be used where the concentration of potassium hydroxide will be known as well as the temperature and the contact time.

1.4 Aim of the Study

This research is aim at

1. Finding a scientific and engineering method of peeling cassava other than the traditional way of using knives as widely used

2. Demonstrating other alternative of peeling cassava

3. Enhancing the productivity of cassava in large quantity for economic used

4. Comparing the property of cassava that is peel with knives with that of potassium hydroxide (KOH)

5. Determining the effect of concentration, temperature and contact time as it affect cassava.

1.5 Significant and Economic Important of the Study

The important of this research is to improve the effectiveness and efficient way of peeling cassava other than the traditional method of using knives in most developed world which engage in cassava production in large quantity. The research will also redirect the ministry of agriculture and other government agencies as well as business enterprises whom engage in cassava production in large quantity to patronized the improved scientific and engineering method which will be easier quicker in peeling large quantity of the product. The research will no doubt improved he economic of this developed country including others stake holders due to the large amount of cassava that will be peel per day. It will also improved food production especially in Nigeria and other West African country.

Traditionally cassava peeling is done manually; the low output of the product and peelers (usually women) however has made scientific and engineering method of peeling cassava necessary. Beside the fact that optimization of some of these parameter to peel the back skin of cassava where most of the cyanide reside, it also facilitate the processing of cassava into edible and industrial products. It will also enhance the economic input whereby low output of the product is made when its peel manually thereby increasing it productivity.

Due to it un- uniform configuration of cassava roots and irregularity in size, it thickness and it strength of it adhesion to the flesh which makes the traditional peeling challenging in bringing out large output the optimization method will expand and turn out the small quantity of the product to large output so as to meet the increasing demand for domestic used.

At the end of the text.

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[1] Cassava wikipedia (free encyclopedia)

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CHAPTER TWO

2.0 LITERATURES REVIEW

Some part of the literature is hereby review under the following topics

2.1 Cassava

Cassava is a shrubby, tropical, perennial plant that is not well known in the temperate zone. For most people, cassava is most commonly associated with tapioca. The plant grows tall, sometimes reaching 15 feet, with leaves varying in shape and size. The edible parts are the tuberous root and leaves. The tuber (root) is somewhat dark brown in color and grow up to 2 feet long. (Cassava free encyclopedia)

Cassava thrives better in poor soils than any other major food plant. As a result, fertilization is rarely necessary. However, yields can be increased by planting cuttings on well drained soil with adequate organic matter. Cassava is a heat-loving plant that requires a minimum temperature of 80 degrees F to grow. Since many cultivars are drought resistant, cassava can survive even during the dry season when the soil moisture is low, but humidity is high. (Cassava production and utilization in Africa FIRRO) Around the world, cassava is a vital staple for about 500 million people. Cassava's starchy roots produce more food energy per unit of land than any other staple crop. Its leaves, commonly eaten as a vegetable in parts of Asia and Africa, provide vitamins and protein. Nutritionally, the cassava is comparable to potatoes, except that it has twice the fiber content and a higher level of potassium.(Cassava production and utilization in Africa)

The cassava used in Indies International Cassava Chips is known by the Latin name (Manihot Utilisima). (Cassava free encyclopedia) It is grown in the farm lands surrounding the town of Bogor in West Java, Indonesia, about 37 miles south of Jakarta, Indonesia's capital city. Indonesia, cassava is used in a variety of food products, the same way potatoes are used in the U.S. They can be used as vegetables in dishes, grated to make pancakes, dried and company ground into tapioca flour or sliced and made into snack and chips. (Indies Hani Nex cassava 2006)

2.1.1 Uses of Cassava

Cassava is grown for its enlarged starch-filled roots, which contains nearly the maximum theoretical concentration of starch on a dry weight basis among food crops. Fresh roots contain about 30% starch and very little protein. (Cassava free encyclopedia) Roots are prepared much like potato. They can be peeled and boiled, baked, or fried. It is not recommended to eat cassava uncooked, because of potentially toxic concentrations of cacogenics glycosides that are reduced to innocuous levels through cooking. (Indies Hani Nex cassava 2006)

Traditional settings of the Americas, roots are grated and the sap is extracted through squeezing or pressing. The cassava is then further dried over a fire to make a meal or fermented and cooked. The meal can then be dehydrated with water or added to soups or stews. In Africa, roots are processed in several different ways. They may be first fermented in water. Then they are either sun-dried for storage or grated and made into dough that is cooked. Alcoholic beverages can be made from the roots. (Indies Hani Nex 2006)

Young tender leaves can be used as a potherb, containing high levels of protein (8-10%). Prepared in a similar manner as spinach, care should be taken to eliminate toxic compounds during the cooking process. One clone with variegated leaves is planted as an ornamental.

2.1.2 Toxicity of Cassava

Cassava is famous for the presence of free and bound cyanogenic glycosides, linamarin and lotaustralin. They are converted to HCN in the presence of linamarase, a naturally occurring enzyme in cassava. Linamarase acts on the glu in the past; cassava was categorized as either sweet or bitter, signifying the absence or presence of toxic levels of cyanogenic glycosides. Sweet cultivars can produce as little as 20 mg of HCN per kg of fresh roots, while bitter ones may produce more than 50 times as much. The bitterness is identified through taste and smell. This is not a totally valid system, since sweetness is not absolutely correlated with HCN producing ability. In cases of human malnutrition, where the diet lacks protein and iodine, under processed roots of high HCN cultivars may result in serious health problems. (Cassava production, processing and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992- ministry of agriculture and food industry CIAT)

2.1.3 Cultivars

Before the development of national and international breeding programs with cassava there were relatively few cultivars. This is because cassava is propagated vegetative as clones. (Cassava free encyclopedia). Recent releases from breeding programs include clones with resistance to many of the major diseases and pests. Specific cultivar names are mostly regional, with the exception of introductions from international research centers, which carry with them an institutional code. This code is often retained as the name of the cultivar. Cultivar classification is usually based on pigmentation and shape of the leaves, stems and roots. Cultivars most commonly vary in yield, root diameter and length, disease and pest resistance levels, time to harvest, cooking quality, and temperature adaptation. Some clones require 18 or months of growth before they can be harvested. Storage root color is usually white. A few clones have yellow-fleshed roots.

Most clones were selected by farmers from chance seedlings in their fields. Each growing region has its own special clones with farmers growing several different ones in a field. (Cassava free encyclopedia)

2.1.4 Production Practices

Cassava is planted using 7-30 cm portions of the mature stem as propagates.(cassava free encyclopedia). The selection of healthy, disease-free and pest-free propagates is essential. The stem cuttings are sometimes referred to as 'stakes'. In areas where freezing temperatures are possible, the cuttings are planted as soon as danger of frost has past. The cuttings are planted by hand in moist, prepared soil, burying the lower half. When soils are too shallow to plant the cutting in an upright or slanted position, the cutting are laid flat and covered with 2-3 cm soil. Mechanical planters have been developed in Brazil to reduce labor inputs. Observing the polarity of the cutting is essential in successful establishment of the cutting. (Indies Hani Nex cassava 2006) .The top of the cutting must be placed up. Typical plant spacing is 1m by 1m. Cuttings produce roots within a few days and new shoots soon appear at old leaf petiole axes on the stem. Botanical seeds are used only for breeding purposes. Early growth is relatively slow, thus weeds must be controlled during the first few months. Although cassava can produce a crop with minimal inputs, optimal yields are recorded from fields with average soil fertility levels for food crop production and regular moisture availability. (Cassava free encyclopedia). Optimal growth and productivity of the plant is related to its harvest index, root weight divided by total plant weight. The desirable indexes range from 0.5 to 0.7. Responses to macro-nutrients vary, with cassava responding most to P and K fertilization. Vesicular-arbuscular (VA) mycorrhizae benefit cassava by scavenging for phosphorus and supplying it to the roots. High N fertilization, more than 100 kg of actual N/ha may result in excessive foliage production at the expense of storage root development and a low harvest index. Fertilizer is only applied during the first few months of growth. Commercially produced fungicides and pesticides are seldom used, with none being registered for use in the U.S.A. There is no mature stage for cassava. Plants are ready for harvest as soon as there are storage roots large enough to meet the requirements of the consumer. Under the most favorable conditions, yields of fresh roots can reach 90 cm, while average world yields from mostly subsistence agricultural systems are 9.8 cm. Typically harvesting can begin as soon as eight months after planting. In the tropics, plants can remain un-harvested for more than one growing season, allowing the storage roots to enlarge further. However, as the roots age, the central portion becomes woody and inedible. (Indies Hani Nex 2006)

2.1.5 Harvesting

Most cassava is harvested by hand, lifting the lower part of stem and pulling the roots out of the ground, then removing them from the base of the plant by hand. The upper parts of the stems with the leaves are removed before harvest. Levers and ropes can be used to assist harvesting. A mechanical harvester has been developed in Brazil (indies Hani Nex 2006). It grabs onto the stem and lifts the roots from the ground. Care must be taken during the harvesting process to minimize damage to the roots, as this greatly reduces shelf life. During the harvesting process, the cuttings for the next crop are selected. These must be kept in a protected location to prevent desiccation.

2.1.6 Cassava food consumption (world)

Both cassava roots and leaves are suitable for human consumption. The first are an important source of carbohydrates and the second, of proteins and minerals. Some cassava roots contain large amounts of cyanohydrins that emanate cyanide, a toxic for human health, and give the root a bitter taste. Cultivars are accordingly classified as sweet or bitter depending on their cyanide content. Bitter varieties are especially fitted for industrial and feed purposes, because of their higher starch content, while sweet varieties are generally preferred if the root is designated to be consumed as food. Unlike sweet cassava, bitter cassava is not safe for human consumption unless properly treated. The primitive inhabitants of the Americas knew about cassava toxicity and developed several techniques to remove the cyanide from the bitter cassava by peeling, grating and squeezing the root. The cyanide-free moist cassava pulp was then baked or dried and could be stored for several months. These same techniques are still widely in use in several tropical countries. A typical cassava root is composed of moisture for 70 percent, starch for 24 percent, fiber for 2 percent, and protein for 1 percent and other elements for 3 percent (Cassava production, processing and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992-ministry of agriculture and food industry and CIAT) Because of its high water content, the root is bulky and highly perishable, so processing should be carried out within 48 hours of harvest. Thus, processing permits to enhance the value of the product by removing the naturally-occurring toxins found in the root; it reduces the weight of the product, thereby facilitating its transportation to markets; it lessens post-harvest losses arising from breakage of the roots; and extends the product's shelf-life.

Cassava is consumed as food only in the developing countries. Between 1984 and 1994, total cassava food use rose from 76 million tones to 96 million tones or 2.4 percent per annum. This growth was faster than in the previous decade, reflecting a dynamic expansion in Africa, in contrast with the stagnation that characterized cassava food consumption in the other regions. (Cassava production, processing and marketing in Vietnam- proceeding of a workshop held in Hanoi, October 1992- ministry of agriculture and food industry and CIAT).

2.1.7 Food Use Growth

Cassava food growth is presented in table 2.1

Table 2.1 Cassava Food Growth in Developed Country.

Growth in %					
World	64,731	75,737	95,997	1.6	2.4
Developing Countries	64 538	75 607	95 935	1.6	2.4
Africa	33,835	43,133	62,558	2.5	3.8
Latin America and the Caribbean	11,572	10.,787	11,528	-0.7	0.7
Asia	19,044	21,556	21,733	1.2	0.1
Developed	193	130	62	-3.9	-7.1

On per capital basis, cassava consumption averaged 17.2 kilos per year in 1994, up from 15.9 kilos in 1984. At the world level, it supplied less than 2 percent of the daily calorie intake in 1994, compared with 20 percent for wheat and 21 percent for rice. In Africa the contribution of cassava to calorie intake averaged 10 percent, less than that of wheat or. Maize (15 percent each) but more than that of rice (7 percent). (cassava production, processing and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992-ministry of agriculture and food industry and CIAT). However, the calories supplied by cassava exceeded 50 percent of total intake in the Democratic Republic of Congo and were of the order of 35 percent in Angola, the Republic of Congo and Mozambique. Outside of Africa, cassava is a basic food in Paraguay, where it provides 14 percent of total calories, only slightly less than maize (15 percent), the main staple. (Cassava production and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992-ministry of agriculture and food industry and CIAT). Per capital cassava consumption has followed an upward trend in Africa in the 1980s and 1990s, but has declined in all the other regions. Several studies have shown a negative correlation between the rate of urbanization and cassava consumption. There is less evidence of a negative relationship between cassava consumption and disposable incomes as demand for fresh cassava has in the low and medium income range. Despite a lack of documented evidence been shown to increase with earnings for population groups on the influence of prices on the demand for cassava food products at the country level, this is likely to be strong given the tight competition with alternative foods, including cereals and other roots and tubers.

Cassava Food Use per Capital

Cassava food use per capital is presented in table 2.2

Table 2.2 Cassava Food Used per Capital

Years	1973–75	1983–85	1993–95	1973–75
World	15.5	15.9	17.2	0.3
Developing Countries	21.5	21.2	22.3	-0.1
Africa	83.5	86.2	97.2	0.3
Latin America and the Caribbean	37.3	27.6	24.4	-3.0
Asia	8.7	8.1	6.8	-0.7
Oceania	22.8	24.1	17.3	0.6

2.1.9 Market Analysis

In the 1990s, world trade in cassava products, excluding trade among EC countries, has fluctuated between 5 million tones and 7 million tones In product weight (between 14 million tones and 19 million tones in root equivalent), or about 10 percent of global production. (Cassava production, processing and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992-ministry of agriculture and food industry and CIAT). The bulk consists of pellets and chips for feed (85 percent) and the balance of starch and flour for food and industrial uses. Trade in fresh cassava is rather limited because of the bulkiness and perish ability of the roots. As a result, it is mostly confined to exchanges between bordering countries. Thailand and Indonesia are the major suppliers of cassava to the world market, contributing some 80 and 10 percent of total trade respectively, while the remainder is provided by small exporters in Africa, Asia and Latin America, including Ghana, Madagascar, Nigeria, Tanzania, China, Vietnam and Brazil (Indies Hani Nex 2006). Exports from these countries, however, have fluctuated, hindered by the irregularity of supply and by structural problems, in particular the lack of infrastructure for inland transportation and long distances to port facilities. The European Community is the main destination of cassava traded products, in particular chips and pellets for the feed industry. Imports there were facilitated by the low tariff applied on those volumes purchased under the preferential access provisions and the high cereal prices prevailing in member countries. Since the mid-1980s, a few alternatives markets have developed, especially in the Far East and in the former USSR but much of the cassava trade continue to depend heavily on EC imports. . (Cassava production, processing and marketing in Vietnam-proceeding of a workshop held in Hanoi, October 1992-ministry of agriculture and food industry and CIAT)

2.2 Cassava Trade

Cassava world trade is presented in table 2.3

Table 2.3 Cassava Trade

	1973	1983	1993	1995	1996	1997	1998
	(in million tones)						
World Exports	1.7	7.2	7.3	5.2	5.8	6.4	4.9
Thailand	1.4	6.7	5.9	3.9	4.6	5.3	3.9
Indonesia	0.2	0.3	0.3	0.5	0.4	0.2	0.2
China	0.0	0.1	0.3	0.4	0.4	0.5	0.5
Others	0.1	0.1	0.8	0.4	0.4	0.5	0.5
World Imports	1.7	7.0	7.3	5.2	5.8	6.4	4.9
EC	1.5	5.4	5.1	3.3	3.5	3.6	2.9
China	0.0	0.4	0.6	0.5	0.3	0.6	0.5
Japan	0.0	0.3	0.4	0.3	0.3	0.3	0.3
Korea Rep.	0.0	0.2	0.4	0.2	0.6	0.5	0.5
Others	0.2	0.1	0.8	0.9	1.1	1.4	0.7

2.3 Varieties of cassava

"Bitter" and "Sweet" are the two general types of cassava. The "Sweet" type is more commonly grown due to its greater yields. Colors and texture of the root, peeling is often the only factor used in separating clones in the market. it contain only a small amount of the acid and are boiled and used as a vegetable, along with the young leaves. The roots are also used for animal feed and the starch is used for glue, laundry starch, and tapioca

b. The batch type of peeling machine does not required the cassava root being cut before peeling, the root are introduce into the drum that is mounted on a shaft which rotate at a predetermined speed. Inert abrasive element is usually introduced into the drum to aid the peeling. As the drum rotate the complex side to side and up and down motion of the drum enable the cassava root to be almost completely peeled. The abrasive process is enhancing by continuously spraying water on the root. This type of batch peelers is capable of peeling at least 140kg of cassava plant (Indies Hani Nex 2006).

2.6 Optimization

The process of synthesizing physical or chemical properties with a goal of creating or improved it properties or production. The optimization of some parameters is carried out to enhance the productivity of cassava; these parameters include temperature, contact time and concentration.

2.7 Concentration

The concentration of a solution is the amount of hydrogen or hydroxide ion that a compound will contain when it reacts with water under standard condition. In optimization of cassava peeling using potassium hydroxide (KOH) is used with a concentration ranging from 1mole 0.5 mole and 0.75mole. From the literature a concentration of 1 to 0 75 moles is capable of peeling cassava under a specific period of time and temperature. (~~Advance Chemistry by Phillips Mathew~~ year of publication). A temperature of 1mole was first prepared follow by 0.5mole and 0.75mole respectively

The concentration of KOH was prepared as follow

Molecular weigh of KOH =57.I

K=39.1

O=16

H=2

1 mole ....57.1g 1000ml

0.5 mole ....28 5g 1000ml

0.75 mole ....14 25g 500ml

2.8 Physical Properties of KOH

Boiling point; 760°C

Melting point; 63.25°C

Specific gravity; 0.862

Classification; alkali metal

Density; 0.856g/cc

Atomic radius; 235pm

Atomic volume; 45.3 cc/mol

Appearance; soft, waxy, silvery-white metal

Covalent radius; 203pm

Ionic radius; 133(+1e)

Specific heat at 20ocj/g mol; 0.753

Fusion heat (kJ /mol); 102.5

Evaporation heat; 2.33 (kj/mol)

Lattice structure; body-centered cubic (Los Alamos national laboratory 2001 crescent chemical company 2001)

2.8.1 Chemical Properties

1. KOH will dissolve in 100ml of water.

2. KOH sublimes unchanged at 400°c

3. KOH reacts with organic compound (New school chemistry by Osei Yaw Ababio).

2.8.2 Uses of KOH

1. Its use in the manufacture of soap

2. Its use as an electrolyte

3. Its use in niche applications

4. Its is use as precursor to other potassium compound (Los Alamos national laboratory 2001 crescent chemical company 2001)

2.8.3 Temperature

Temperature is the degree of hotness or coldness of a body. The optimization of cassava peeling involved application of temperature within a specific period of time. A temperature of (28,30and 32) °C is use which was measured with a aid of thermometer. (Los Alamos national laboratory 2001 crescent chemical company 2001)

2.8.4 Contact Time

A contact time of (5, 10 and 15) min was used in the optimization of cassava peeling with a aid of a devised call time device

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CHAPTER THREE

3.0 METHODOLOGY

Optimization of cassava peeling using potassium hydroxide (KOH) is a scientific method of peeling the outer cortex of cassava. In optimization of this parameter such as concentration, temperature, and contact time are to be varies within a specific range from the literature review. The method used to achieve the aim of this research is the second order factorial method (3*3) experimental design. An experimental design plant is drawn where the parameters to be optimized will be varies thereby generating an regression equation of the second order factorial model in the form of

$$Y=a_o+a_1x_1+a_2x_2+a_3x_3+a_{11}x_1^2+a_{22}x_2^2+a_{33}x_3^2+a_1a_2x_1x_2+a_1x_3x_1x_3+a_2a_3x_2x_3 + \ldots \quad 3.1$$

Where y= average weight of the cassava

a= coefficient

X= variable (concentration temperature and contact time)

3.1 Procedure

The optimization of cassava using potassium hydroxide (KOH) is carried out under scientific standard conditions. This is a method of enhancing the productivity of peel cassava to meet the global demand of the product. From the literature review, cassava soaked in either potassium hydroxide (KOH) or sodium hydroxide (NaOH) can peel cassava under specified concentration, temperature and contact time. In this process, cassava source from the market is to be wash and cut with knife into weight ranging from (10.00 – 10.04) gram.

A concentration of 1mole of KOH is to be first prepared in a volumetric flask and store in a reagent bottle. Proper preparation of the reagent will determine if the cassava will be peel or not which the aim of the experiment is. The cassava is to be place in a 25ml or 100ml beaker depending on the size of the cassava. The 1mole concentration of KOH which was prepared is pour in a beaker containing the cassava just above the level of the cassava. The mixture is to be heated in a heating device by setting the temperature of the device at 30 °C, a thermometer is to use to measure the temperature of the mixture to ensure that the temperature is at 30 °C. After a time interval of 15minute, the cassavas is to removed and wash with cold water and allowed to be drain before reweighing. The initial weigh and the final weight of the cassava are to be read and recorded, and that will determine if the cassava is peel or not.

The experiment is to be carry out for the same concentration of 1mole for temperature of (28 and 32) °C as well as contact time of (10 and 5) min respectively after which another concentration of (0.5 and 0.75) mole is prepare and the procedure is to be repeated for temperature of (32, 30 and 28) °C and contact time of (15, 10 and 5) min respectively. The average of the initial weight Y_1 and final weight $Y_2 = (Y_1+Y_2)/2$ is to be computed and recorded.

3.2 Equipment Used

The equipment used for this research work is presented in table 3.1

Table 3.1 Equipment Used

EQUIPMENT USED	SOURCES	COMMENT
Thermometer	England 210-050T	Use in measuring the temperature of the mixture
Volumetric flask 500ml in 20 ^{o} C	Western Germany	Used in diluting KOH to the desire concentration
Beaker 600mls	Smilax Czech republic	For storing concentrated KOH
Stirrer	Chernyshor U.S.A	Used in mixing the heating process
Funnel	Chemical engineering laboratory F.U.T Minna	Used in transporting KOH to the volumetric flask
Beaker 25ml	TechNet U.S.A	
Digital weighing machine	Husking China	Used in measuring the weight of the cassava
Heating device CAT NO 0780 10 volt 240 watt	Germany	Used in warming the cassava mixture to the desired time interval
Conical flask		Use in warming the mixture
Stop watch	Liz Faulkner Ireland	Used in timing the heating process
Knife	Chemical engineering laboratory F.U.T Minna	Used in cutting the cassava into the desire weight

3.3 Material Used

The material used in this research work is presented in table 3.2

Table 3.2 Material Used

S/NO	MATERIALS USED	SOURCES	COMMENT
1	Distilled water	Chemical engineering laboratory F.U.T Minna	Used to prepared the concentration of KOH
2	Solid KOH	Chemical engineering laboratory F.U.T Minna	Its used in preparing a concentration of (1, 0.5, and 0.75) mole
3	Cassava	Minna central market	Used in optimization process

3.4 Flow Diagram

The flow diagram for scientific /chemical method of peeling cassava is presented in the figure 3.2

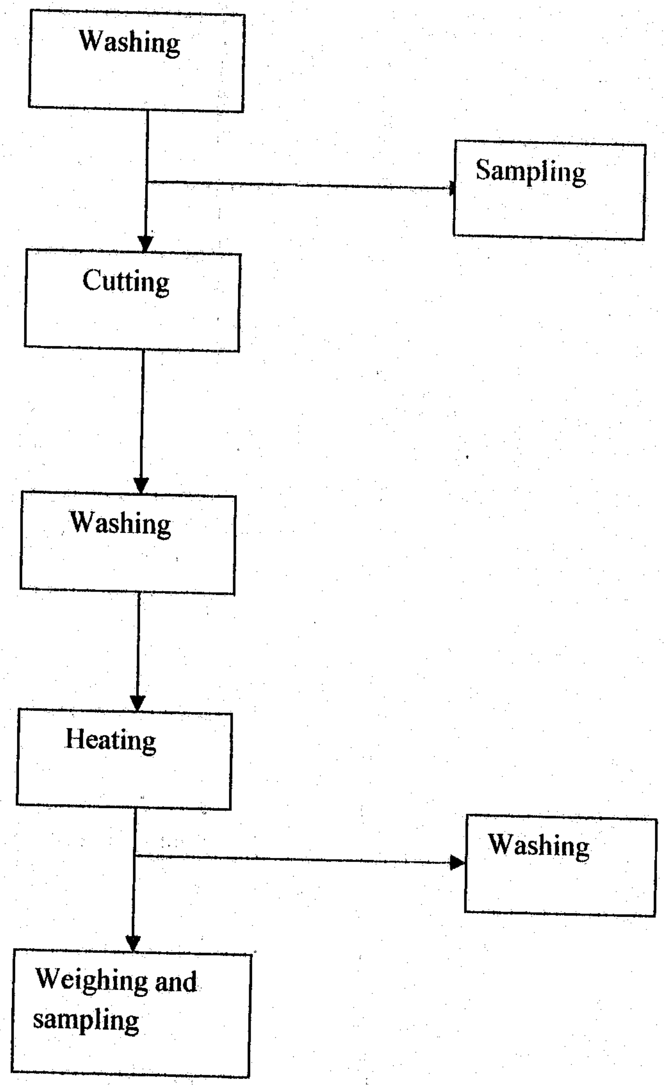

Fig 3.2 Flow diagram for scientific (optimization) method of peeling cassava

3.5 Experimental Design Matrix

The experimental design matrix is shown in table 3.3

Table 3.3 Experimental design matrix for optimization of temperature, concentration and contact time on cassava peeling.

s/no	X_o	X_1	X_2	X_3	Y_1	Y_2	ΔY
1	+	+	+	+			
2	+	-	+	+			
3	+	0	+	+			
4	+	+	-	+			
5	+	-	-	+			
6	+	0	-	+			
7	+	+	0	+			
8	+	-	0	+			
9	+	0	0	+			
10	+	+	+	-			
11	+	-	+	-			
12	+	0	+	-			
13	+	+	-	-			
14	+	-	-	-			
15	+	0	-	-			
16	+	+	0	-			
17	+	-	0	-			
18	+	0	0	-			
19	+	+	+	0			
20	+	-	+	0			
21	+	0	+	0			
22	+	+	-	0			
23	+	-	-	0			

24	+	0	-	0
25	+	+	0	0
26	+	-	0	0
27	+	0	0	0

X_1 = Concentration of KOH in mole

X_2 = Temperature in °C

X_3 = Contact time in min

Y1= initial weight

Y2= Final weight

ΔY= Change in weight

CHAPTER FOUR

4.0 Experimental Result

The experimental result of optimization of cassava peeling is presented in table 4.1

Table 4.1 Experimental result of optimization of some parameters on cassava peeling using potassium hydroxide.

S/NO	X_O	CONC MOLE X_1	TEMP ^oC X_2	TIME MIN X_3	INITIAL WEIGHT Y_1	FINAL WEIGHT Y_2	AVERAGE WEIGHT (Y)
1	+	1	32	15	1.00	0.80	0.90
2	+	0.5	32	15	1.20	0.60	0.90
3	+	0.75	32	15	0.60	0.40	0.50
4	+	1	28	15	0.60	0.30	0.45
5	+	0.5	28	15	1.20	1.30	1.25
6	+	0.75	28	15	1.10	1.20	1.15
7	+	1	30	15	0.20	0.20	0.20
8	+	0.5	30	15	1.10	1.40	1.25
9	+	0.75	30	15	0.20	0.10	0.15
10	+	1	32	5	0.80	0.80	0.80
11	+	0.5	32	5	0.90	0.90	0.90
12	+	0.75	32	5	0.50	0.60	0.55
13	+	1	28	5	0.40	1.10	0.75
14	+	0.5	28	5	0.50	1.00	0.75
15	+	0.75	28	5	0.30	0.20	0.75
16	+	1	30	5	0.10	0.10	0.10
17	+	0.5	30	5	1.60	1.40	1.50
18	+	0.75	30	5	0.40	1.30	0.85
19	+	1	32	10	0.10	0.20	0.15
20	+	0.5	32	10	1.90	1.20	1.55

21	+	0.75	32	10	0.90	1.20	0.95
22	+	1	28	10	0.60	0.30	0.45
23	+	0.5	28	10	1.60	0.50	1.05
24	+	0.75	28	10	0.70	0.50	0.60
25	+	1	30	10	0.60	0.50	0.55
26	+	0.5	30	10	2.10	2.00	2.05
27	+	0.75	30	10	0.30	1.10	0.70

4.1 Analyzed Result

This result of optimization of cassava peeling using potassium hydroxide was analyzed using Minitab software and is presented in table 4.2

Table 4.2 Analyzed Result

Term	Coefficient	SE Coef	T	P
Constant	0.62037	0.19649	3.157	0.006
CONCENTRATION	-0.44167	0.09096	-4.856	0.000
TEMPERATURE	0.10278	0.09096	1.130	0.274
TIME	0.09167	0.09096	1.008	0.018
CONCENTRATION*CONCENTRATION	0.41389	0.15755	2.627	0.328
TEMPERATURE*TEMPERATURE	0.03056	0.15755	0.194	0.849
TIME*TIME	-0.08611	0.15755	-0.547	0.592
CONCENTRATION*TEMPERATURE	-0.12083	0.11140	-1.085	0.293
CONCENTRATION*TIME	-0.21250	0.11140	-1.908	0.073
TEMPERATURE*TIME	0.04167	0.11140	0.374	0.713

4.2 Unusual Observations for Weight

The Minitab soft ware observed an unusual behavior in some data and is presented in table 4.3

Table 4.3 un-usual behavior of analyzed result

Obs	StdOrder	WEIGHT	Fit	SE Fit	Residual	St Resid
9	12	1.150	0.512	0.226	0.638	2.04 R

R denotes an observation with a large standardized residual.

4.3 Regression Equation

$$Y = 0.62037 - 0.4417\ X_1 + 0.10278\ X_2 + 0.09167\ X_3 + 0.41389\ X_1^2 + 0.03056\ X_2^2 - 0.08611X_3^2 - 0.12083X_1X_2 - 0.21250X_1X_3 + 0.04167X_2X_3 \quad \ldots\ldots 4.1$$

Where X_1= Concentration

X_2 =Temperature

X_3 = Contact Time

The significant P-value or α-value is 0.05; any value greater than this is regarded as insignificant and can be done away with.

This implies that the reduced first order regression equation can be re-written thus;

$$Y = 0.62037 - 0.44167\ X_1 + 0.09167\ X_3 - 0.21250\ X_1X_3 \quad \ldots\ldots 4.2$$

4.4 Optimized Results

The optimized result is presented in fig 4.4 – 4.6

4.4.1 Contour Plot

Contour plot of weight against time and temperature from mini tab is presented below

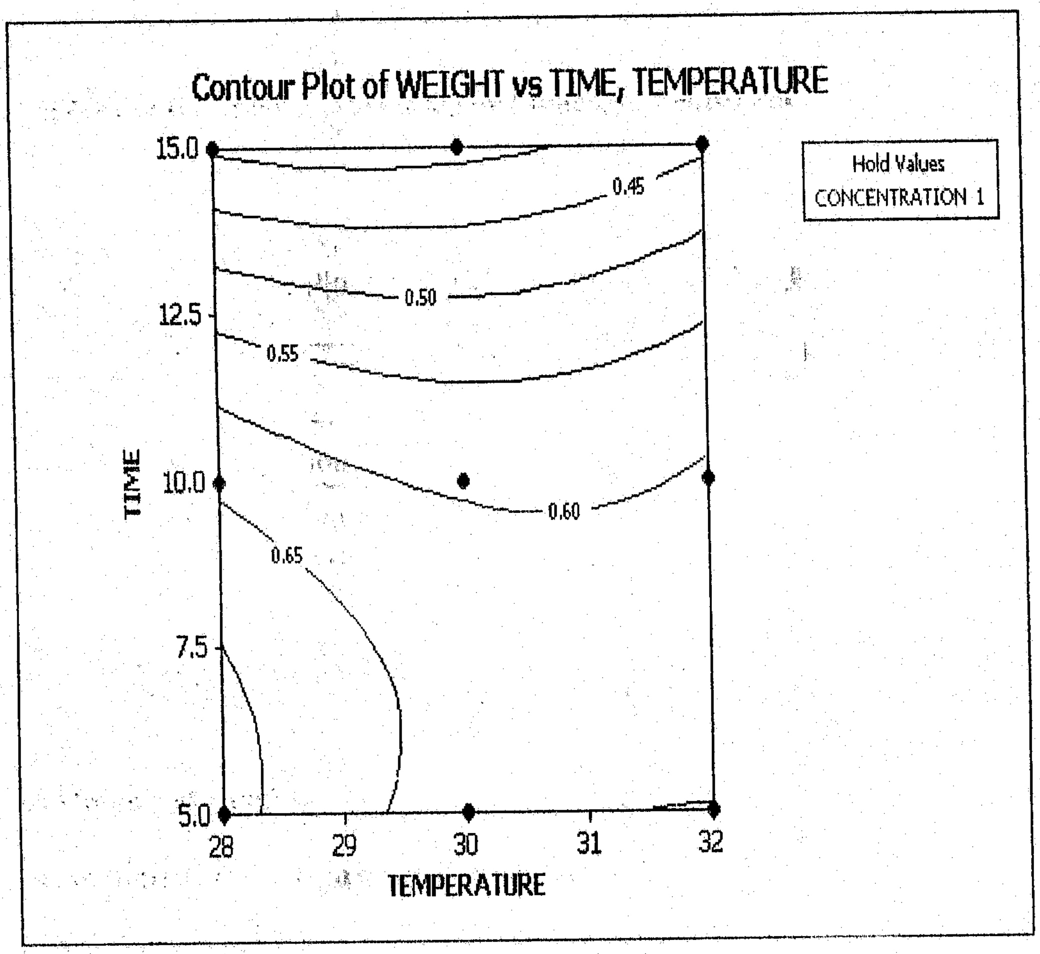

Fig 4.4 Contour plot of weight against time and temperature.

4.3.2 Contour Plot of Weight, Temperature and Concentration

The contour plot of weight against temperature and concentration is Presented in figure 4.5

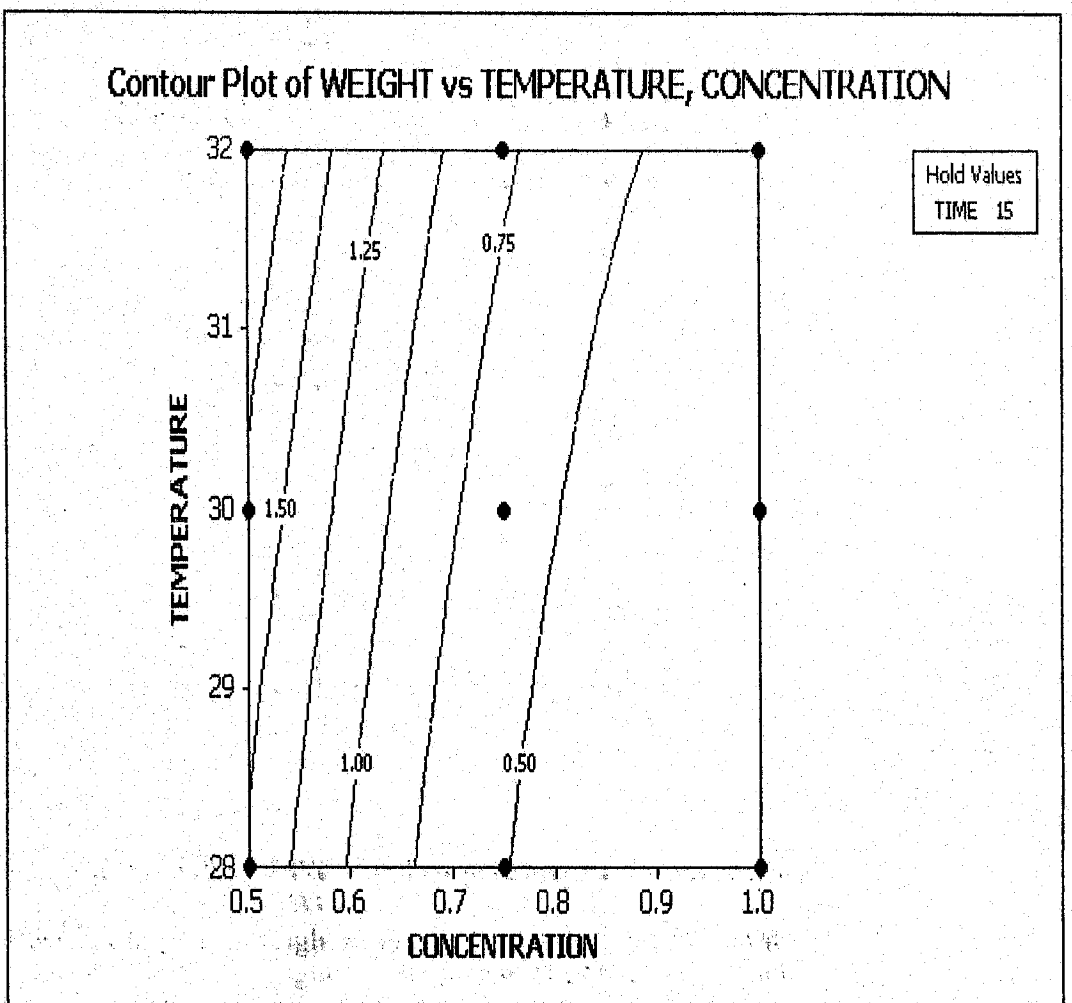

Figure 4.5 contour plot of weight against temperature and concentration.

4.3.3 Contour Plot of Weight, Time and Concentration

The weight against time and concentration contour plot is presented in figure 4.6

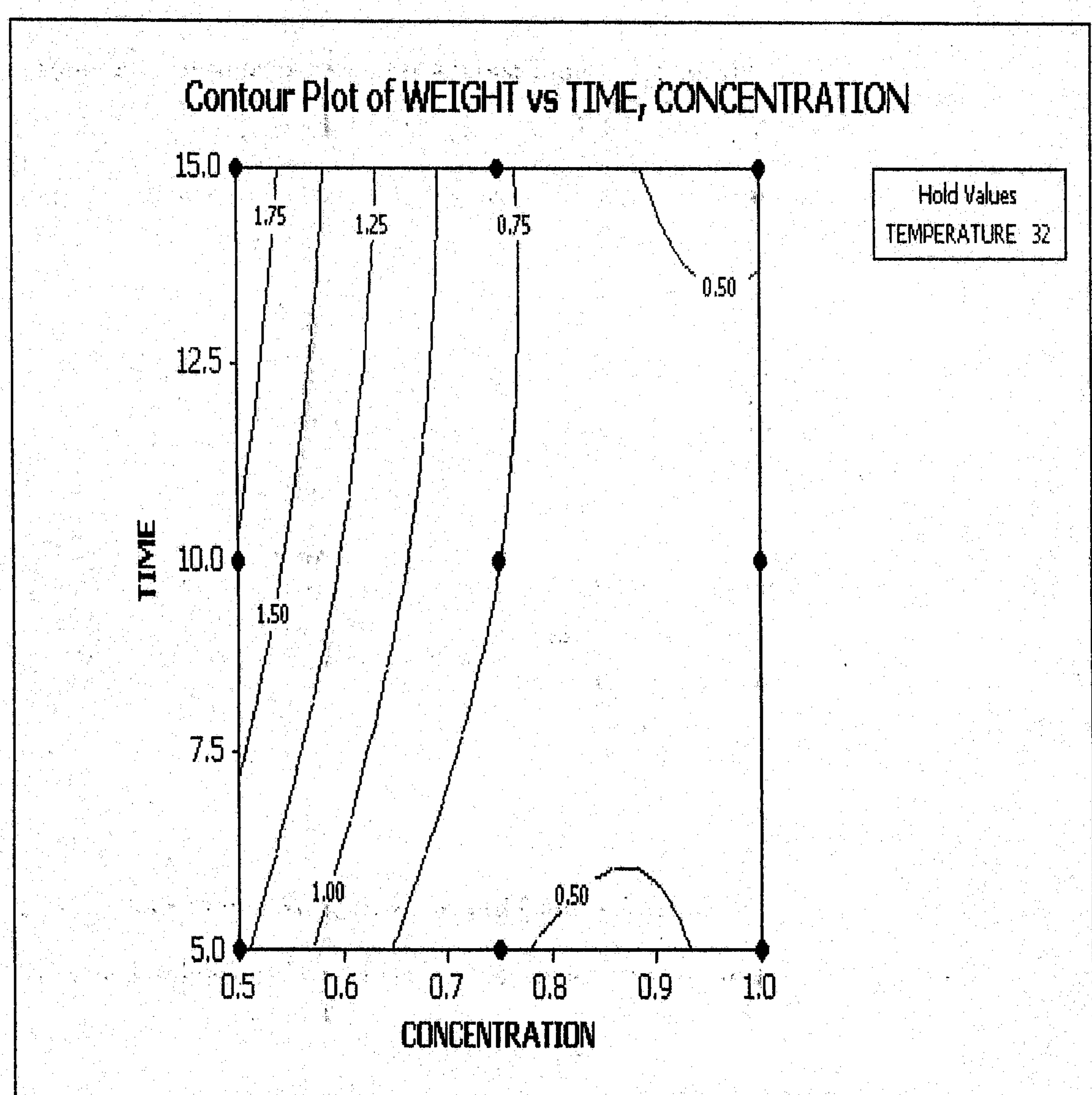

Figure 4.6 Contour plot weights against time and concentration.

CHAPTER FIVE

5.0 DISCUSION OF RESULTS

The results obtain on this research is discussed under the following headings

5.1 Experimental Results

The experimental result obtains shows there is gradual decrease in weight of the cassava as the concentration of the KOH increase as well as the contact time. This indicates that at concentration of 1mole and temperature of 32°C there is a significant effect of these parameters on the cassava. The result obtain in experiment 26 at a concentration of 0.5m a temperature of 30oC and contact time of 10min shows an increase in weight, this indicate the low concentration of KOH used .

5.2 Analyzed Result

The analyzed results shows the effect of various parameters on cassava and it coefficient. A standard error is generated to show an unusual behavior of these parameters as it effect cassava, in observation 9 at standard order 12, there is a standard error of 0.225 with residual of 0.638 this indicate the behavior and effect of the experimental result of this order as it affect cassava . A residual with a large standard value of 2.04 is also generated and any effect with a significant value greater than 0.05 the coded unit of the computer soft ware can do away with it.

From the regression equation generated by Minitab it shows how the parameters interact with each others as it affect the weight of the cassava. Concentration affects the weight of the cassava in a negative direction while temperature and time affect the weight in a positive direction.

The interaction between concentration and temperature and that of concentration and contact time affect the weight of the cassava in a negative direction while the interaction between temperature and contact time affect the weight of the cassava in a positive direction.

5.3 Optimized Result

5.3.1 Contour Plot of Weight, Time and Temperature

The interaction between time and temperature as it affect the weight of the cassava and holding the value of concentration at 1mole, shows that, as the time increases gradually, the temperature increases thereby affecting the weight of the cassava. At time interval of 15minute and a temperature of 32^{O}C the weight of the cassava reduces to 0.45. This shows that the interaction between the two parameters has a significant effect on the cassava.

5.3.2 Contour Plot of Weight, Temperature and Concentration

The contour plot of temperature and concentration on weight shows a gradual effect on the weight of the cassava. At a temperature of 32^{o}c and concentration of 0.5mole the weight of the cassava constant that is has not effect on the weight of the cassava, but at a concentration of 0.75 and a temperature of 28.5 when the value of time is held at 15minue, the weight reduces to 0.05 which shows a significant effect on the cassava when temperature interact with concentration.

5.3.3 Contour Plot of Weight, Time and Concentration.

The interaction between time and concentration occur only when the two parameters interact at significant values. When the temperature is held at 32^{O}C, the interaction of the two parameters affect the weight of the cassava at a concentration of 1mole.

Chapter Six

6.0 Conclusion

The conclusion drawn from this research work shows there is improvement in the productivity of cassava using the scientific/ engineering approach method, the man power used in peeling the cortex with knife as used world wide is enhance with this method. The UN usual behavior of the result obtain in this analysis indicates that there is a graduation of height weight during the course of this experiment and it can be avoided.

6.0 Recommendation

This project work should be properly funded for further research to improve this method of peeling.

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