DETERMINATION OF PHYSICAL AND CHEMICAL PROPERTIES OF CASHEWNUT

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CERTIFICATION

This is to certify that this project work was carried out by Iliyasu, Yusuf in the department of Agricultural Engineering, Federal University of Technology, Minna, Niger state.

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DEDICATION

This project is dedicated to my loving parents, Alh. Mohammed Iliyasu and Hajiya Kaka Iliyasu.

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ALL PRAISE IS DUE TO ALMIGHTY GOD. My greatest thanks goes to Almighty God for his love, mercy, protection and blessing since my childhood to this day. He who gave me the chance to write this project, through the experience and knowledge gained from the Department of Agricultural Engineering for several years.

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ABSTRACT

The physical and chemical properties of cashewnut, which is relevant to industrial application and use were selected for study. Ten physical properties and Five chemical properties of cashewnut were studied using standard test and experiment.

The results showed that cashew nut has an average major diameter of 3.1mm, minor diameter of 2.1mm and intermediate diameter of 2.0mm. It also has an average weight of 6.72×10^{-3}kg, volume of $7.2 \times 10^{-6}m^3$, density of $933kg/m^3$, surface area of $6.0 \times 10^{-4}m^2$, sphericity of 0.75, moisture content of 2%, roundness ratio of 2.18, the colour of cashewnut is brownish, the shape of cashewnut is kidney-shaped. The chemical reactivity of CNSL with phenol-formaldehyde form phenol-polymer, Neutralization of CNSL with base (NaOH) form crystalline salts, flammability of cashewnut shell particles give off unpleasant smell, blue-yellow light, heat and leaving the black residue, acridity and corrosivity of cashewnut fresh juice and oil cause a blistering of skin and eye irritation, the CNSL react with potassium hydroxide (KOH) gives acid value of less than 20mg/KOH/g.

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INTRODUCTION

1.0 Background to the study

The cashew (Anacardium occidendentale L) belongs to the family ANACARDIACEAE which include many economically important Tropical and Sub-tropical trees and shrubs. The cashew is native to south-eastern Brazil and widely distributed through out the tropical world from America seacoast to the West Indian. Its growth as favoured by a mild tropical climate and the crop is susceptible to freezing temperatures.

The fruit consist of the swollen fleshy pedicel and an exposed seed. The pedicel as juicy astringent, nutritious and is characterized by a pleasant flavour. It is rich in ascorbic acid, sugar and vitamins.

The seed is the source of cashew nuts used in confectionery and desserts. (Rodriguuez *et al.* ,1975). According to (Shivashankar *et al.* ,1983). Cashew apple is not a true fruit but a swollen peduncle to which the cashew nut is attached. It is soft but fibrous juicy fruits possessing exotic flavour. Base on the external colour of the fruit, the cashew apple can be broadly classified into two types: Red and Yellow. (Salunke & Desil, 1984).

The real seed totally difference from the cashew apple is a kidney-shape achene with an epicarp, commonly called shell. The pericarp protects the seed also called kernel, which is enveloped in a brown skin, the intergament or "testa". The seed is made of two developed kidney-shaped cotyledon and the embryo. The average weight of a whole fruit

varies from 25-38g or more according to variety and cultivation conditions. (Lonchoistrobin, 1994). The hard kidney-shaped nut of the cashew forms the raw materials for the processing industries in order to separate the pericarp from the seed, the cashew nut is roasted and separation is done either manually or using mechanical methods.

1.1 Growth of Plant

Cashew plant can be grown at an elevation as high as 1000m but it does best below 500m (Hanges, 1953). The cashew trees sometimes reach a height of 12m. They have large, leathering, green leaves up to 15cm long and 10 cm wide. (Jaynes, 1958).

1.2 Nutrition Value of Cashewnut

The cashew is one of the most nutritive tropical food crops with its high protein and fat content. It has appreciable amount of minerals such as calcium, phosphorous, iron and vitamins. (Salunled and Desail, 1984).

1.3 Cultivars of cashew nut

Cashew being a cross-pollinated crop has led to a large variation in the seedling progenies. The yield performance studies carried out at the All India Coordinated Cashew nut improvement project showed that progenies of Vridhacalam type such as M10/4, M6/1 and M12/3 were the higher yield cover 10kg per tree.

The size and quality of apple were also good. (Desail and Salunke,1984).

1.4 Production and Distribution of cashew nut

The cashew nut production and distribution leads all other tree nuts with its world production of 450, 000 metric tonnes (MT). It ranks third (20% of the market). In the international trade of nut crops after hazelnut (29%) and almond (21%), (FAO, 1981)

India is the largest producer of cashew nut producing more than 40% of the world cashew nuts. The other major producers of cashew nuts are Mozambique, Brazil, Tanzania and Kenya. The production of the African countries has significantly decreased during the last decade. (FAO, 1981).

1.5 Aim and Objective

The aim and objective of this project work is to determine the physical and chemical properties of cashew nut which should be taken into consideration before any cashew processing plant could be designed.

1.6 Justification of the Objective

The study of physical and chemical properties of cashew nuts has been an attempt to provide objective measurement resulting in a meaningful data in engineering analysis and design. These data generated will make designers to conceptualize appropriate method of processing cashew nut and as a result help in maximizing the productivity of cashew nut.

1.7 Scope of the Study

The physical and chemical properties of relevant industrial properties have been selected for study within the scope of this project.

CHAPTER TWO

LITERATURE REVIEW

2.1 Maturity Harvesting and Handling of Cashew Nut

Cashew apple is ripe when the basic colour of the outer skin turns yellow or yellowish red. The greenish colour of immature nuts turns brown when mature. Generally, ripped fruits fall to the ground and they are gathered manually. Sometimes they are detached from the peduncle or cashew apple, although manual detachment can provoke the fall of flowers, small fruits and unripe fruits. Partial mechanization of cashew harvest is possible, adapting the techniques used for olives such as nuts and shakers and also separation of the fruit from cashew apple can be mechanized, provided that producers are interested in trying new methods.

At present, gradual ripening imposes harvesting at short intervals (2-4 days) for peduncle, or longer interval (7 – 10 days) when they are not to be used for processing. In fact, while fruits may remain on the ground for 7 – 10 days without damaging the kernels. Cashew apple may rot on the ground during the same length of time, jeopardizing production.

After harvesting and the detachment of fruits from their peduncle, they cannot be stored because of their high moisture content. That is why they were desiccated and exposed to sun for 4-5 days in layers. When moisture decreases, the fungus attacks reduce, so storage methods are used for seeds or other foodstuff.

(Pontastico *et al*.,1975) recommended a storage temperature of 0 ^{0}C to 1.7 ^{0}C with 85-90% relative humidity. Under these conditions, the cashew nut can be stored for up to 5 months. The commercial harvest of cashew nut starts from the 5th to 6th year of planting and the economic life of a cashew tree is about 40 years. (Linchoistrobin, 1994).

2.2 Production Features and Uses of Cashew Nut

2.2.1 Cashew Apple

The cashew apple forms as a result of peduncle hypertropic development and it can be consumed both fresh or processed. When it is ripe, the cashew apple is yellow-green, dark red or reddish coloured according to its origin population. Its weight varies from 15-500g and its shape may be cylindric, pinform or a truncated-cone. Its juice consist of chemical composition has high sugar content of 10% and high vitamin C content of 200g of juice (Soare, 1986).

The juice is commercialized for direct consumption, as a freshed or preserved product and for the fermentation and preparation of alcoholic beverages. It may be consumed immediately after squeezing or it can be preserved after filtration, bottling and pasteurization.

2.2.2 Cashew Nut

The cashew nut which is the real fruit of cashew and has a kidney-shaped. It is attached to the end of a fleshy stalk which is the receptacle of the flower, broadened and swollen forming the false fruit. The nut has a pericarp commonly called the shell which

comprises 45%-50% of the entire weight of the nut. It is made up of three concentric layers namely: the epicarp, the mesocarp and the endocarp.

The spongy mesocarp of the shell contains a sticky, resinous liquid called Cashew Nut Shell Liquid(CNSL) which offers the kernel (seed) natural protection against insect. The kernel is enveloped in a brown thin resistant intergnment called "peel". The kernel is in formed of two kidney-shaped cotyledons inside which is the embryo. When cashew nut is processed, the main product is the kernel while the peel, shell and CNSL are the by-products.

Figure 2.1

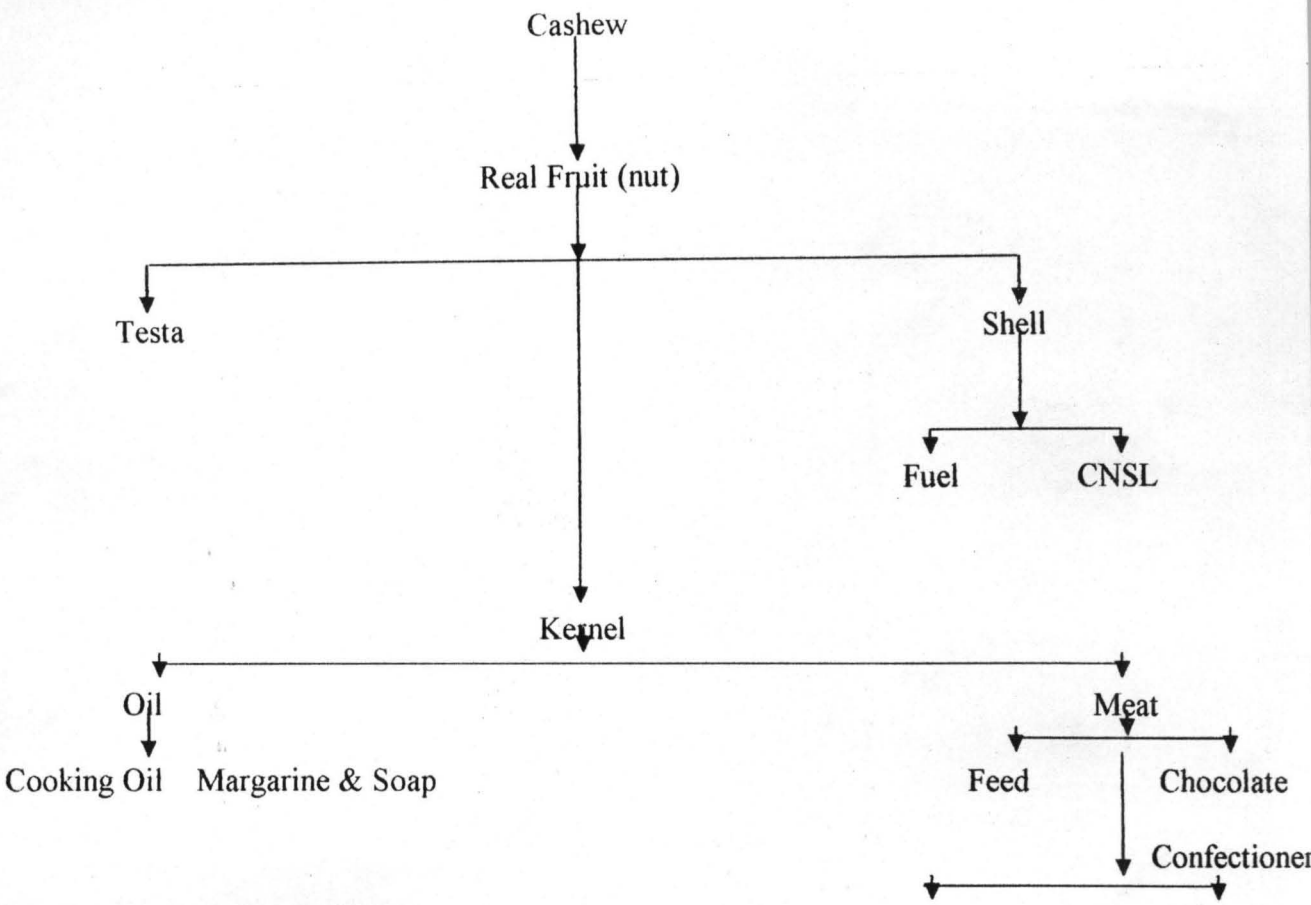


Fig. 2.1 Cashewnut Processing

Source: Ogunshina (1997).

Physical Features of a Cashewnut

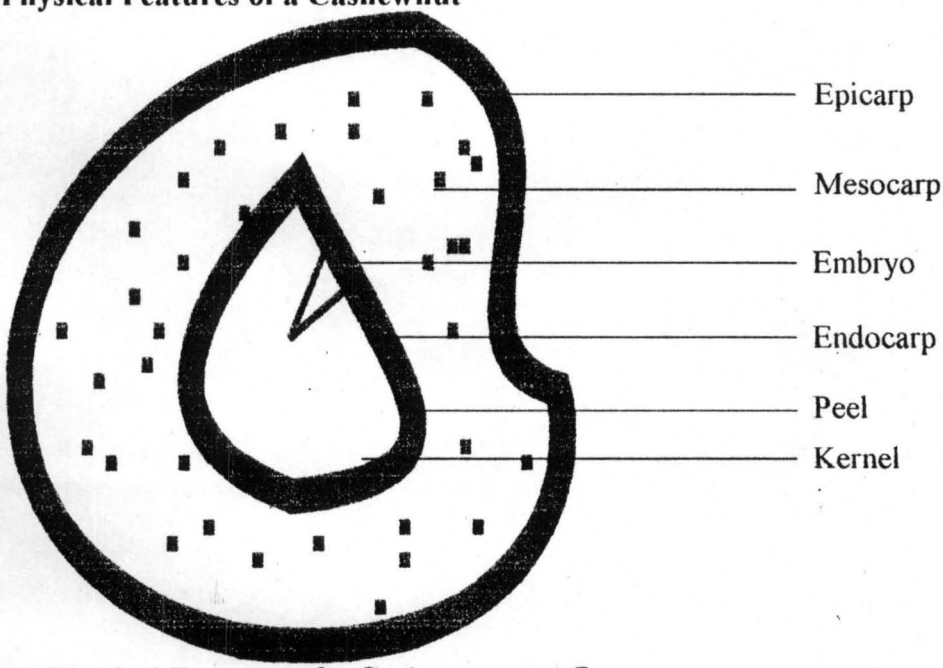


Fig 2.2 Physical Features of a Cashewnut

2.2.3 Cashew Nut Shell Liquid (CNSL)

Description: The Cashew Nut Shell Liquid is the by-product of cashew industry and is sourced primarily from South America and Asia. The nut has a shell of about 0.1 inch thickness inside it there is a soft honeycomb structure containing a dark reddish brown viscous liquid comprised of different unsaturated alkyl substituted phenols. It is called the cashew nut shell liquid which is the pericarp fluid of the cashewnut. This is a purely natural product and no chemical is added.

The cashew fruit mesocarp or nut is a spongy tissue containing a corrosive resin known as CNSL, of 30 – 40% on the whole pericarp or shell, (Soares, 1986). CNSL is viscous, dark brown and can be purified using chemico-physical process like: purification, decarboxylation, hydrogenation and esterification.

CNSL from the pericarp maybe extracted by surfacing in a hot bath, but with a very low yield, or by the squeezing, with 90% yield. The remaining 10% is extracted by means of solvents. CNSL composition when cold extraction is used, is 90% anacardic acid and 10% cardol. (Corria, 1963).

During extraction, the anacardic acid losses the COOH radical thus it decarboxylates giving cardanol. Industrial uses of CNSL are mainly in the rubber industries. However, 90% of the CNSL are used to make resins utilized for clutches, for drum and disk-brake. CNSL by-product may also be used to prepare paints-Harnishes, enamel, insecticides-fungicides, pigments, plasticizers, adhesives, special quality lacquers and water-proof emerge paper.

2.2.4 The Kernel

Like all other seeds, the cashew kernel is made up of a lipid and a protein, besides starchy substances and mineral salt contained in ash. It is clear that cashew kernel has high liquid of 46% content and medium protein of 19.5% content. The cashew kernel accounts for 20-25% of the whole nut at processing and is the main product of cashew nut processing. (Lincloistrobin, 1994).

Roasted and fried kernels, salted and sugared are demand all over the world as snacks to accompany drinks at cocktails as ingredients when preparing food and as basic ingredients for confectionaries. Apart from being a tasty and energy giving food. The nutritious characteristic of cashew kernel makes it highly digestible and very suitable for the preparation of infant formula, and some old age diets. (Lincloistrobin, 1994).

(Lincloistrobin, 1994). Also reported that cashew kernel contain nearly all the amino acids needed for human consumption. It contains high almonds of organic calcium, phosphorous and iron seldom found in daily diets.

(Abraham, 1936) also reported that the cashew kernel protein has been found to be very rich and readily digestible. It contain calcium, iron, phosphorous, vitamin A and B, Nicotinic acid and Riboflavin. It is therefore a highly nutritious and perfect food for man.

Table 2.1: The Cashewnut Composition

S/No	Composition	Weight of Cashewnut
1	Kernel	20-25 of the nut weight
2	Shell	60-70% of the nut weight
3	Peel	2-5% of the nut weight
4	CNSL	18-23% of the nut weight

Source: (Ogunshina B.S., 1997).

Table 2.2: The Percentage Constituent of Cashewnut

S/No	Constituents	Percentage
1	Moisture	5.9
2	Carbohydrates	22.0
3	Protein	21.0
4	Fat	47.0

Table 2.3: The Mineral Constituent of Cashewnut

S/No	Minerals	Percentage
1	Calcium	0.05
2	Phosphorous	0.45
3	Iron	0.005

Source: (Anon, 1984).

Being a cholesterol food, the cashew kernel can also be processed and consumed as butter and it has been found to be a good additive in making of confectioneries such as

chocolate. Due to all these a large amount of cashew kernel is consumed in Brazil, USA, Russia, Japan and Australia.

2.3 Cashew Nut Processing

The real fruit of the cashew is a kind of nut whose spongy mesocarp contains a liquid known as CNSL. The kernel is covered by a thin resistant peel which is not edible. Cashew nut processing must take into account the characteristics of the nut, avoiding changes in colour and breakage of the kernel during roasting, shelling and peeling.

Cashew nut processing began in India in the 20's with manual shelling and peeling. Just before the second world war the first attempt were made to soften the shell to facilitate shelling by putting the nut in CNSL at a temperature of 200 ^{0}C. Later research was undertaken to mechanize partly or totally the shelling phase. Completely mechanized system for the processing of cashew nut were set up until the 60's.

2.3.1 Indian Method

Today in India cashew nut processing is still carried out using traditional method in what may not be defined as real factories. The raw material is prepared for shelling either by being moistened or dried in the sun. The nuts are then roasted in the hot CNSL or put in the rotating drum heated over a fire. In some regions an autoclave is used before shelling or this operation is done without roasting.

Shelling is often carried out at home by individual workers paid on the basis of whole kernels yield. Shelling is done by hand with hammer or with pedal-operating shears. The kernel are then dried before manual peeling. After grading the kernel are packed for shipping.

2.3.2 Brazilian Method

In Brazil the manual system has been progressively set aside and substituted by mechanized processing based on Sturtevant-Fletcher system fig 2.3. This is mainly due to changes in the socio-economic conditions in a country where the increasing influence of trade unions and high salaries make the mechanization of cashew processing necessary.

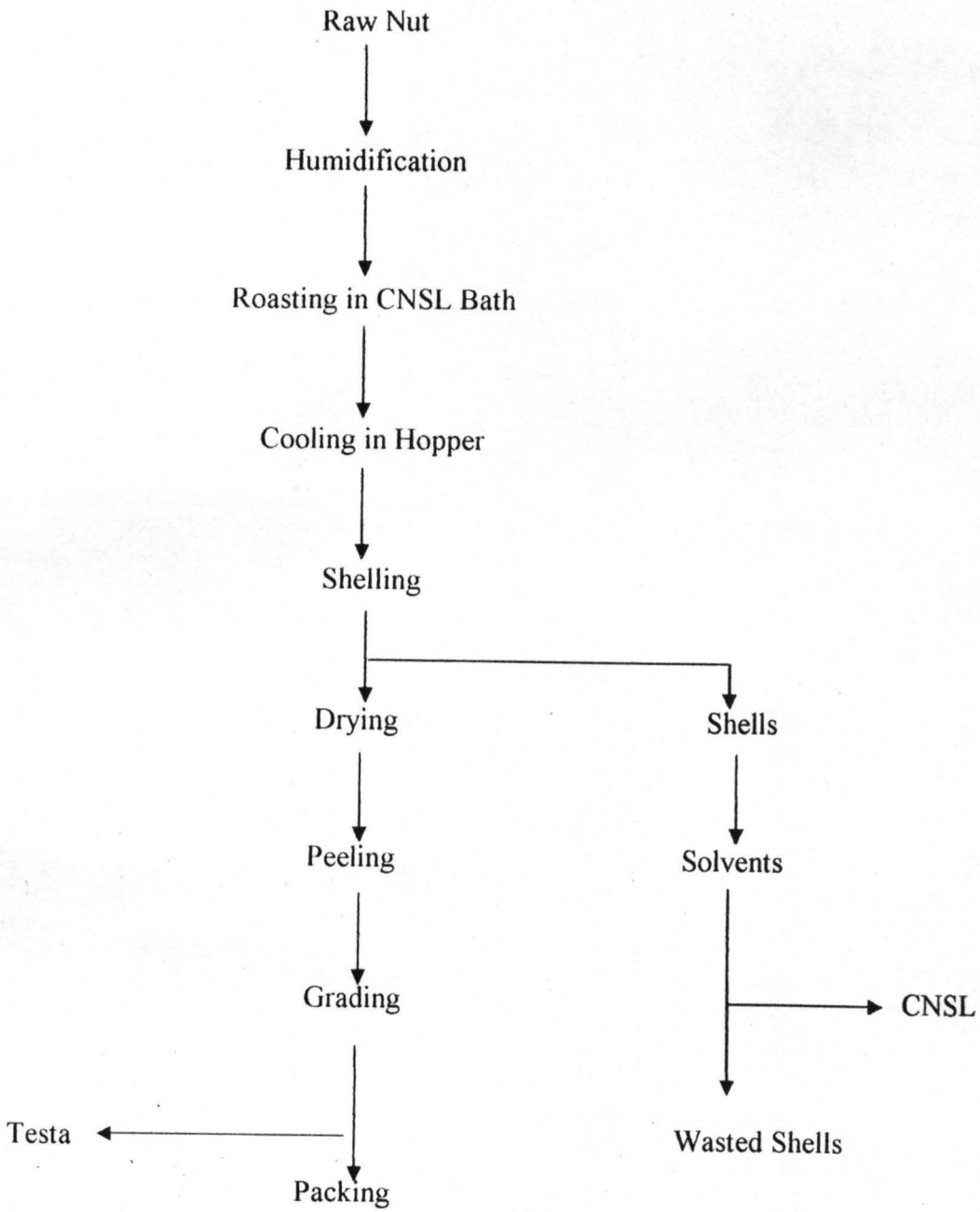


Fig 2.3. Sturtevant – Fletcher Mechanized System
Source: Ogunshina (1997)

2.4 The Production Process of Cashewnut

The Oltrmare Mechanical System of cashew nut processing involves nine (9) stages of operation. Any consignment of cashew nut contains plant debris, small stones and particles which constitutes impurities. These are removed during washing. From washing machine, the nuts come out graded into three sizes viz: large, medium and small. The nuts are humidified for a period of 6-72 hours to increase the moisture content. There is no fixed regulation on how to carry out humidification because the operation is highly affected by the nature of the nuts, place of harvest and initial moisture content. Each lot of humidified (large, medium or small) nuts are roasted at a temperature of 190 ^{0}C-200 ^{0}C and allowed to cool for 24 hours. Cooling is necessary to facilitate shelling. During roasting the nuts (large, medium or small) go into the same cooling hopper and get mixed up as a result. The nuts are therefore callibrated again into large, medium or small to facilitate proper shelling. During shelling the nut is cracked. Shelling is perharps the greatest bottle neck along the processing line as the achievement of production target is highly dependent on the capacity of the shelling machine. After shelling, separation of the kernels from the shells is achieved by a pneumatic mechanism. The moisture content of the kernel at this stage is between 6%-7%.

The kernels are subjected to 70 ^{0}C – 80 ^{0}C to reduce the moisture content to 3% at which the test is dry enough to facilitate peeling. (Ogunshina, 1997). During peeling, the outer covering of the kernel testa is removed. In addition, the kernels are calibrated into : whole, split and pieces. The peeled kernel undergo sorting and resorting directly, while the unpeeled ones are peeled by hand before sorting and resorting is carried out. Hand peeling, sorting and resorting of kernels are labour intensive operations requiring

thorough supervision and quality control monitoring for good results. During sorting and resorting , the kernels are graded according to colour, size, structure based on acceptable international market standards.

As a result of consumers and commercial buyers increasing preference for white whole kernel, the general target in any cashew nut processing plant is to get a high percentage of white kernels. Other grades are: dessert whole, Butts, splits and pieces. The kernels according to these grades are packed. Packing of kernels into galvanized tins is done harmatically with introduction of carbondioxide for preservation. . (Ogunshina, 1997).

2.5 Types of Available Extraction Methods of CNSL

There are three different methods generally used in extracting CNSL from cashew nuts. They are mechanical, roasting and solvent extraction methods. However, the most common method of commercial extraction of CNSL are Roasting and solvent extraction methods.

Roasting Method

Under roasting method, we have "Hot-oil-bath' roasting and 'open-fire" roasting methods.

a. **'Hot-oil-Bath' Roasting:** - In this method, the nuts a re roasted in a bath filled with CNSL at 170-190 ^{0}C. The nuts are dipped in the bath in wire traps or passed through it in a screw convey or a special conveyor belt. As the nut are roasted, the cells in the skin burst, releasing the liquid into the bath. The excess liquid overflows out of the bath and is collected. The CNSL is presumed to be expel by

the rapid volatilization of the water in the shell. About 90% of the CNSL is recovered in this way.

b. **'Open-Fire' Roasting:** - The roasting is done over an 'open-fire' in open perforated pans of the earthen wire or sheet meter at 180-240 ^{0}C or with perforated rotating cylinders suspended in an inclined position over a furnace stired to prevent scorching and to ensure uniform roasting. The CNSL is caught in receptacle, through much of it is lost.

Another 'hot method' is the treatment of the nuts in vertical tanks through which super heated stream of up to 270 ^{0}C is passed. About 95% of CNSL is collected in a receptacle placed under the nuts. The liquid obtained by this way is considered to be of better quality than that obtained by other "Hot" methods

Another 'hot method' is the treatment of the nuts in vertical tanks through which super heated stream of up to 270 ^{0}C is passed. About 95% of CNSL is collected in a receptacle placed under the nuts. The liquid obtained by this way is considered to be better quality than that obtained by other 'Hot' methods.

Solvent Extraction Method

The extraction of a soluble constituents from a solid by the use of liquid solvent is generally referred to as leaching. The mechanism of leaching may involve simple physical solution or dissolution made possible by chemical reaction.

The rate or transport or solvent into the solvent, or of extract solution out of the insoluble material, or of the solute from the solution in contact with particles to the main bulk of solution, or some combination of these rates may be involved and a chemical reaction rate may also affect the rate of leaching.

2.6 Chemical Composition, History and Structure

The cashew-nut was first examined by Cadet, who found in it gallic acid and an acrid resin. Afterward, (Mattos, 1931). By a more careful investigation, found in addition, tannin, an extractive substance, a gun-risen, and some green coloring matter. But the most interesting investigation, was made by Staedeler, in 1948, who examined the viscid liquid contained between two shells of the nut, having extracted it by means of ether.

Natural (i.e cold, solvent extracted) CNSL contains approximately 70% anacardic acid 18% cardonol, and 5% cardol, with the remainder being made up of other phenols and less polar substances. As shown in figure 2.4, anacardic acid, cardonol and cardol consist of mixtures of component having various degrees of unsaturation in the alkyl side chains.

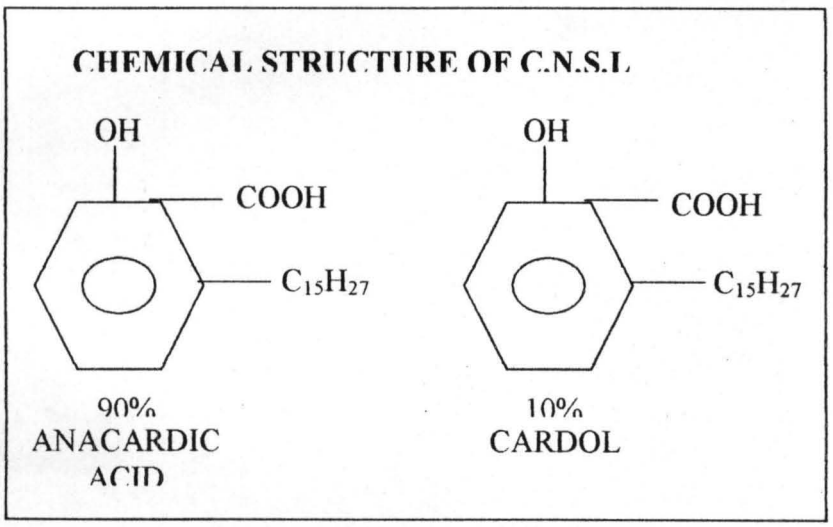
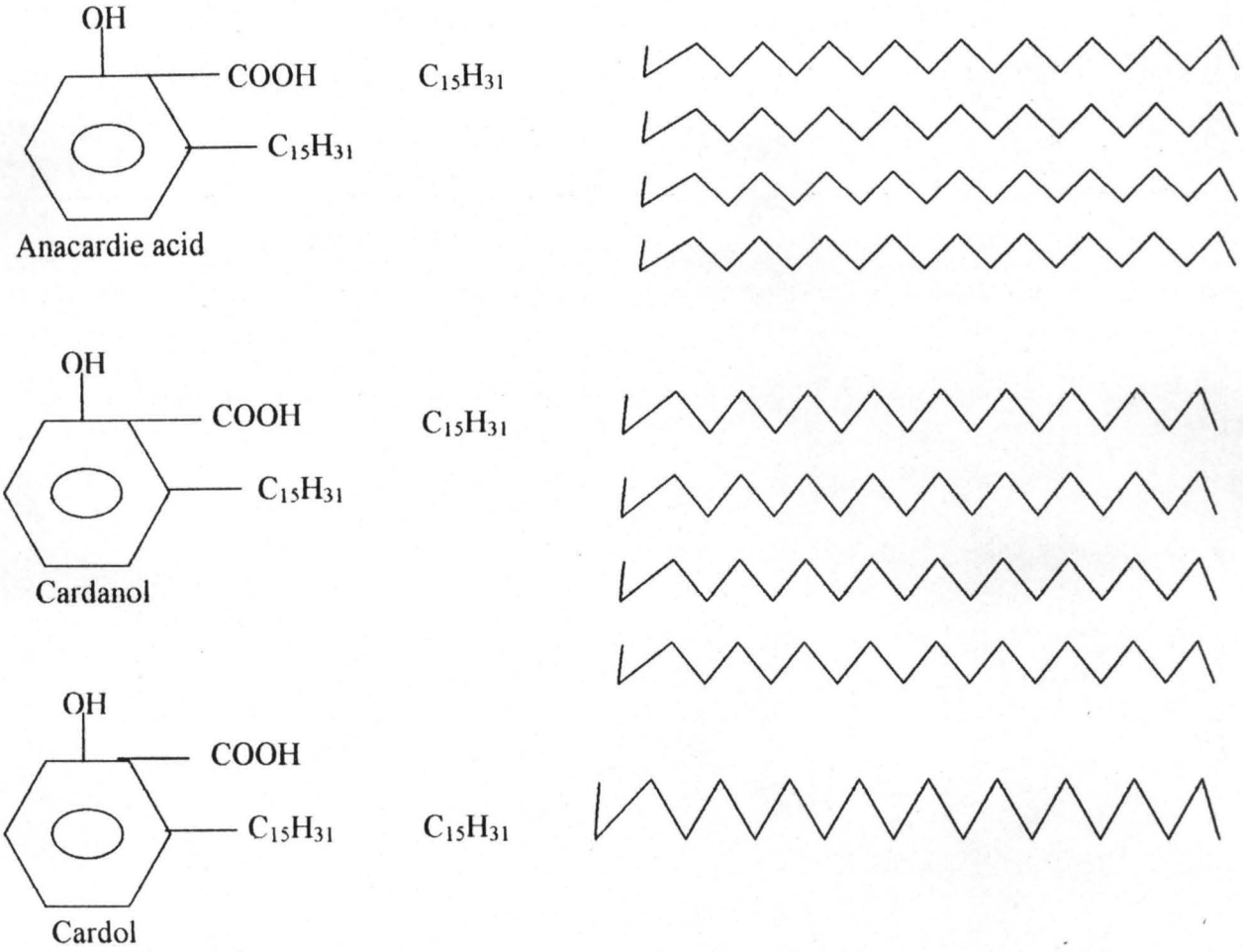


Figure 2.4. Structures of Anacardic acid, cardonol and cardol.



In technical (i.e heat extracted) CNSL, heating process leads to decarbonxylation of the anacardic acid to form cardonol. Typically, the composition of technical CNSL is 52% cardonol. 10% cardol 30% polymeric material, with the remainder being made up of other substances.

2.7 Physico-Chemical Properties

Information in engineering is the fundamental bedrock into innovation. As a matter of fact, it will undoubtedly enhance techno-scientific development with respect to food production.

To increase the economic importance of cashew nuts production together with the complexity of modern technology for its engineering properties must be carefully studied and understood as they play important role in the design of machine structure processes and control.

The annual production of CNSL for export has varied considerably. But it has always been on upward trend, estimates for the consumption of CNSL within producing countries are unreliable, but the figures given are in the region of $1x10^9$ tonnes for Brazil, $2x10^9$ tonnes for India while $5x10^8$ tonnes seems to be used in Africa.

CNSL resin 158006 is manufactures as a black, moderately brittle, slightly rubbery solid with the following physico-chemical properties:melting point, 57-65 ^{0}C; specific gravity, 1.0 at 25 ^{0}C water solubility, <1 g/1 at 25 ^{0}C; self-polymerises at temperature above 80 ^{0}C; is not expected to hydrolyse; is combustible and likely to be insoluble in water.

CHAPTER THREE

MATERIALS AND METHODS

The main material used in the determination of the physical and chemical properties of cashew nut. The cashew nuts were brought from Kwara State and can be obtained in the market within the month of November and May. The used of textbooks from the library and internet research enable me to carry out the study and research of this project.

Also the use of graphical method, Oven dry method, flame test and volumetric analysis method.

3.1 SELECTED PHYSICAL PROPERTIES OF CASHEW NUT.

3.1.1 Shape of Cashewnut

To determine the shape of the cashew nut, tracing of the longitudinal and lateral cross section of the material was done. This is compared with the shape listed on a charted standard (Mohsenin *et al.*, 1965). Using the standard charts, descriptive terms were used to define the shape of the product over five replicates.

3.1.2 Size of Cashewnut

To determine the size of the cashew nut diameter according to (Mohsenin, 1953) the matually perpendicator axes a and b referred to as major and minor diameter also c referred to as intermediate diameter were measured using Vanier caliper.

3.1.3 Weight of Cashewnut

This is the measurement of quantity of cashew nut e.g. mass in kg unit and counted numbers of cashew nut (N). The weight of cashew nut was determined by using electronic weighing machine.

The weight of cashew nut was then calculated using the formular.

$$\text{Weight of cashew } W = \frac{M}{N} \text{ (kg)}$$

Where M = Mass or weight of cashew nut from the scale

N = Number of cashew nuts counted.

3.1.4 Surface Area Cashewnut

The surface area of the cashew nut was determined by using the graph paper method due to inavailability of a planimeter. The peel of a nut was removed and traced on a graph paper with pencil.

The surface area was then calculated from the area covered by the trace on the graph paper as:

Surface area = sum of the areas of the squares covered by the stripes on the graph paper.

3.1.5 Roundness Ratio of cashew nut

This is a measure of the sharpness corners of cashew nut. The roundness ratio was determined by using the value of largest projected natural area of the circumstances of cashew nut and smallest natural area. Also, by the area of a circle and area of shape.

Roundness ratio was calculated using the formular

$$\text{Roundness ration } Rr = \frac{Ap}{Ac}$$

Where Ap = Area of largest projected nature or Area of shape

Ac = Area of smallest projected nature or Area of circle.

Also using:

$$\text{Roundness ratio } Rr = \frac{r}{R}$$

$$= \frac{\sum r}{NR}$$

(Production Manual)

Where N = Number of corners

R = Radius of circle

$\sum r$ = Sum of Radius of small circle (r)

$= r_1+r_2+r_3.$

3.1.6 Moisture Content of cashew nut

This is the measurement of amount of water content in the cashew nut.

The moisture content of cashew nut was determined by using Rapid oven dry method.

The moisture content was then calculated by using this formular.

$$Mc\ (\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

3.1.7 Volume and Density of cashew nut

Water displacement method was used to determine the volume of the product due to its irregular shape (Mohsenin, 1970). The material was first weighted on a platform scale in air and then forced into water inside a beaker by means of a sinker rod. The second reading of the scale with the product submerged minus the weight of the container and water gives the weight of the displaced water. Using the following expressing. The volume and density were determined. (Mohsenin, 1970).

$$\text{Volume} = \frac{\text{weight of displaced water (kg)}}{\text{Weight density of water (kg/m}^3\text{)}}$$

3.1.8 Colour of cashew nut

The colour of cashew nut determined by reflectivity and absorptivity character using the electromagnetic radiation or by the view of transmission of light.

3.1.9 Sphericity of Cashewnut

This is the measurement of sphericity of cashewnut was determined by obtaining the values of major, minor and intermediate diameter of the cashewnut.

The sphericity was then calculated using the formular.

Sphericity $S = \left[\frac{bc}{a^2}\right]^{1/3}$

(Mohsenin, 1970)

Where a = Major diameter

b = Intermediate diameter

c = Minor diameter

another method.

Sphericity $S = \frac{di}{dc}$ (production manual)

Where di = Diameter of the largest inscribe sphere

dc = Diameter of the smallest circumscribe sphere.

3.2 CHEMICAL PROPERTIES OF CASHEW NUT

3.2.1 Neutralization

This is a process in which cashew nut shell liquid react with bases to form a salt.

The Neutralization of cashew nut shell liquid was determined by using volumetric analysis and seed method. The neutralization of cashew nut shell liquid was obtained chemical equation:

Anacardic Acid + NaOH $\longrightarrow$ Anacardic salt + H_2O.

3.2.2 Flammability

This is the capability of a cashew oil to catch fire or support burning.

The flammability of cashew oil particle was determined by using a Bunsen burner.

3.2.3 Chemical Reactivity

The is the process in which the cashew nut shell liquid changed into different substances.

The chemical reactivity of cashew nut shell liquid was determined by using reagent convection of phenol and formaldehyde condensation of phenol.

The chemical reactivity was obtained by using this chemical equation.

3.2.4 Acridity and Corrosivity

This is a degree of cashew juice to cause irritating poison or burning. The Acridity and Corrosivity of cashew juice was determined by using skin, eye and cloth.

3.2.5 Acid Value of Cashewnut shell liquid

This is the expression of acidity value of cashewnut shell liquid. This acidity value of cashewnut shell liquid was determined by using base. e.g Potassium Hydroxide.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Data obtained from the experiment and test are given in Table 4.1. These results are the mean values obtained over six samples of the product to obtain the physical and chemical properties of cashew nut.

4.1 Shape of Cashew Nut

The shape of the cashewnut as defined by the standard chart are shown in Table 4.1 (Mohsenin 1970).

4.2 Size of Cashew Nut

The highlight of these results and discussion are the major, minor and intermediate diameters.

4.2.1 Major Diameter

The results on Table 4.1 shows that the sample of cashew nut for this study has overall average value of major diameter 3.1mm.

4.2.2 Minor Diameter

The overall mean value of the minor diameter of the cashew nut is 2.1mm.

4.2.3 Intermediate Diameter

The overall mean value of the intermediate diameter of the cashew nut is 2.0mm.

4.3 Weight of Cashew Nut

The mean overall weight of the material for this study is 6.72×10^{-3}kg

4.4 Surface Area of Cashew Nut

The overall average result for the material for this study is $6.0 \times 10^{-4} m^2$

The error encounter during the measurement of surface area using graph sheet method were due to the fact that it is difficult to obtain a perfect tracing of the material on the graph sheet using pencil. It could have been better done by plain meter which is the ideal instrument.

Moreso, counting of the squares on the squares on the graph sheet that falls inside the pencil traced area are cumbersome, since some of the square units are not totally covered by the traced area.

4.5 Roundness Ratio of Cashew Nut

The result obtained shown as

$$\text{Roundness ration} = \frac{AP}{AC} = \frac{\pi(3.1)^2}{4} / \frac{\pi(2.8)^2}{4} = 2.18$$

4.6. Moisture Content of Cashew Nut

The result obtained from this study is shown in Table 4.1.

4.7 Volume and Density of Cashew Nut

The mean volume of the material which is equal to the volume of the displaced water is 7.2×10^{-6} m^3

The density of the material which is mass per volume is 933kg/m^3

4.8 Colour of Cashew Nut

The result obtained from this study is shown in the Table 4.1.

4.9 Chemical Reactivity of Cashew Nut Shell Liquid

The result obtained is shown in Table 4.1.

4.10 Neutralization of Cashew Nut Shell Liquid

The result obtained is shown in Table 4.1.

4.11 Flammability of Cashew Nut Shell Liquid

The result obtained is shown in Table 4.1.

4.12 Acridity and Corrosivity of Cashew Nut Shell Liquid

The result obtained is shown in Table 4.1.

4.13 Sphericity of Cashewnut

The result shown in Table 4.1.

Table 4.1: Result of Physical and Chemical Properties of Cashewnut.

PROPERTIES	MEANS VALUE OF THE PARAMETERS
Shape of cashew	Kidney-shaped
Colour of cashew nut	Brown
Size a. Major diameter b. Minor diameter c. Intermediate diameter	 3.1 mm 2.0 mm 2.1 mm
Weight of cashew nut	6.72×10^{-3} Kg
Volume of cashew nut	7.2×10^{-6} m^3
Density	933 Kg/ m^3
Surface area	3.7×10^{-4} m^2
Moisture content	2%
Sphericity	0.75
Roundness ratio	2.18
Acid value	Less than 20mg/KOH/g
Chemical reactivity	Phenol polymer
Neutralization	Crystalline salt
Flammability	Unpleasant smell, light, heat and black residue
Acridity and corrosivity	Blistering of skin and eye rotation

4.14 DISCUSSION

During the determination of physical and chemical properties of cashewnut, a lot of problems was encountered which made some results not accurately obtained and the used of other alternative method.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The determination of physical properties of cashewnut was carried and graphical, oven dry, flame test, trazing and volumetric analysis method.

The results obtained from cashewnut properties are; brown colour, kidney-shaped, combustible, phenol polymer, salt formation. These results provide a data that could be used in the engineering design and growth of the cashew processing plant.

5.2 Recommendation

I recommend hat the department of Agriculture Engineering should try and purchase a standard equipments that could be used in Agricultural laboratory.

Also, I recommend that the available equipment in the laboratory should be properly maintained.

The University Authority should also provide a special chemical laboratory for the Agricultural Engineering with a standard apparatus and reagent.

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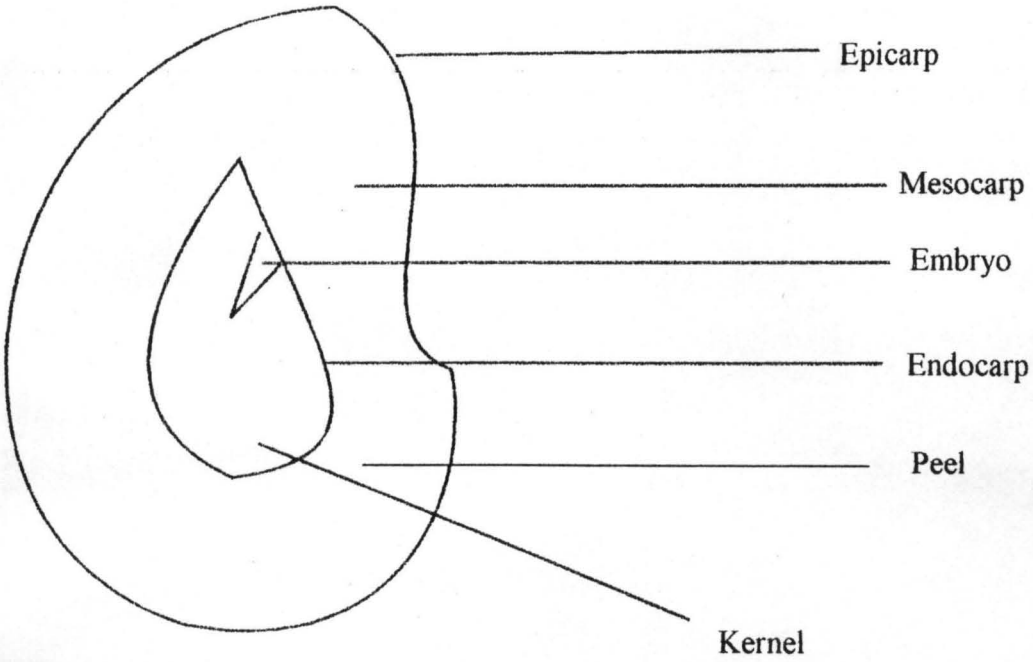
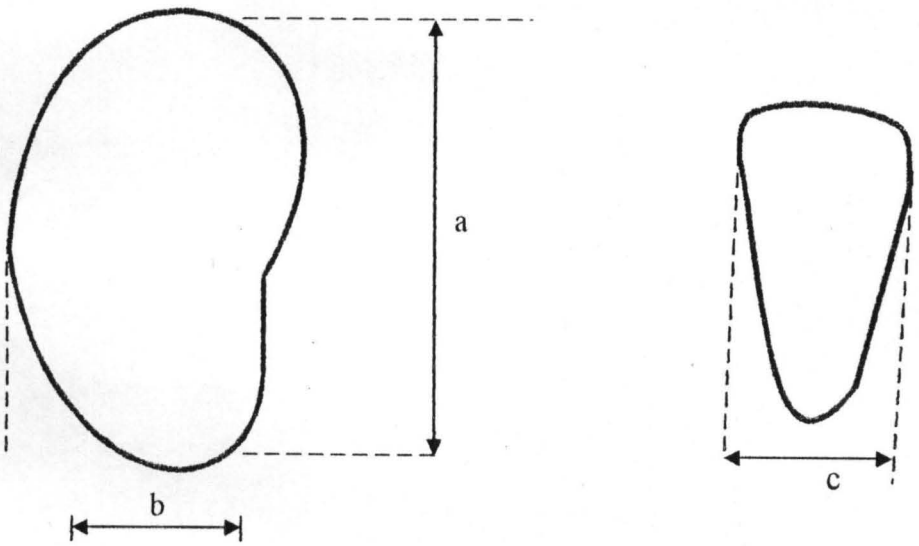
APPENDIX A

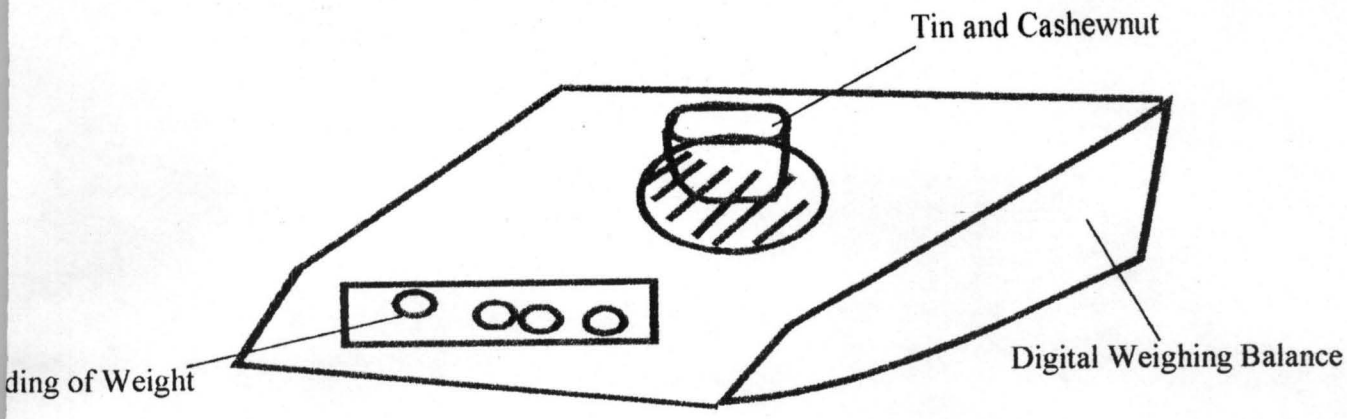
A1: PHYSICAL PROPERTIES OF CASHEWNUT



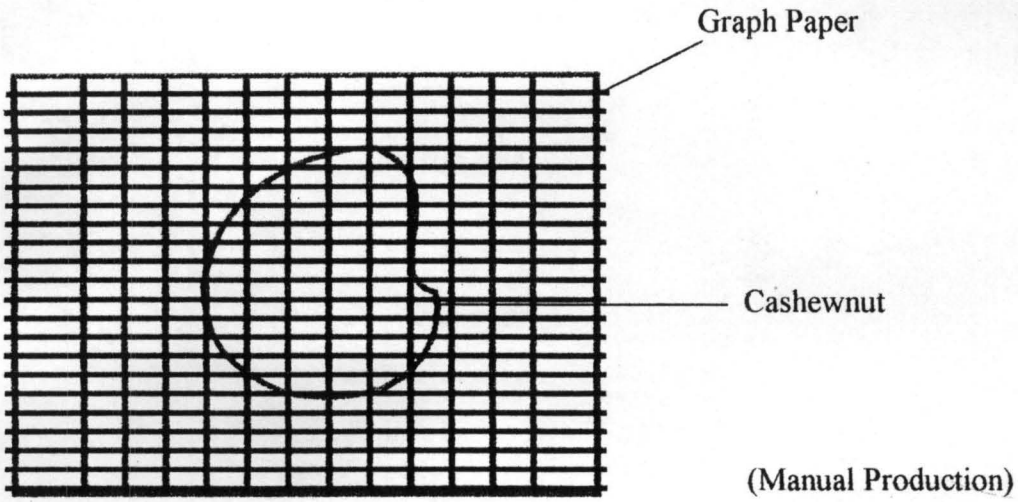
THE SHAPE OF CASHEWNUT



THE SIZE OF CASHEWNUT



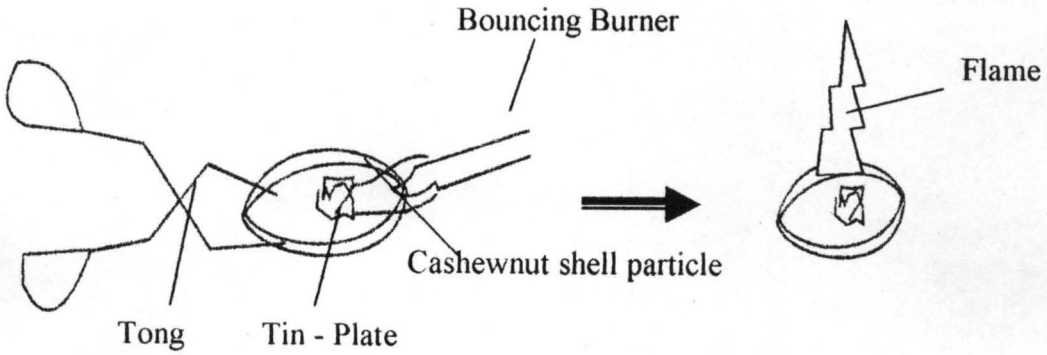
THE WEIGHT OF CASHEWNUT



THE SURFACE AREA OF CASHEWNUT

APPENDIX A

A2: CHEMICAL PROPERTIES OF CASHEWNUT



FLAMMABILITY

APPENDIX B

CALCULATIONS

Shape of cashew nut is described as a kidney-shaped

Size of cashewnut

A = major Diameter = 3.1mm

B = Intermediate Diameter = 2.1mm

C = Minor Diameter = 2.0mm

Weight of cashewnut

Weight of tin W_t = 0.02g

Weight of tin and sample of cashewnut (6) = W_{t+s} = 40.32g

Weight of six samples of cashewnut W = W = $W_{s+t} - W_t$

$= 40.32 - 0.02$

$= 40.3g$

Using six (6) sample

Average weight of cashewnut = $\frac{W}{N}$

$= \frac{40.3}{6}$

$= 6.72g$

Converted to kg: $6.72 \times 10^{-3}kg$

Surface area of cashewnut

Sample "A"

Number of full size square = 351sq unit

Number of half size square = $18 = \frac{18}{2} = 9$sq unit

Number of quarter size square $\frac{4}{4} = 1$sq unit

Total number of square unit = 351 + 9 + 1
= 361sq unit

Sample "B"
Total number of square unit = 371 + 5 + 2
= 379sq unit

Sample "C"
Total number of square unit = 354 + 9 + 3
= 366sq unit

S ample "D"
Total number of square unit = 380 + 5 + 6
= 391sq unit

Sample "E"
Total number of square unit = 348 + 4 + 3
= 355sq unit

Sample "F"
Total number of square unit = 379 + 8 + 5
= 392sq unit.

Total Unit Square = 392 + 355 + 366 + 379 + 391 + 361
= 2199sq units

Average Surface Area $= \frac{2199}{6}$

= 366.5sq unit
= $3.66 \times 10^{-4}m^2$
= $3.67 \times 10^{-4}m^2$

Roundness Ration of Cashewnut

$$Rr = \pi \frac{(3.1)^2}{4} = \frac{7.55}{3.46}$$

$$\pi \frac{(1.1)^2}{4}$$

= 2.18

Moisture content of Cashewnut

The moisture content of cashewnut is obtain show in table 6.

Sphericity of Cashewnut

$$S = \frac{bc)^{1}/_{3}}{a^2} = \frac{2.1 \times 2.0)^{1}/_{3}}{(3.1)^2}$$

$$= 0.75$$

Volume of density

Weight displaced $= 7.2cm^3$

$= 7.2 \times 10\text{-}6m^3$

Weight of cashewnut $= 6.72 \times 10^{-3}$

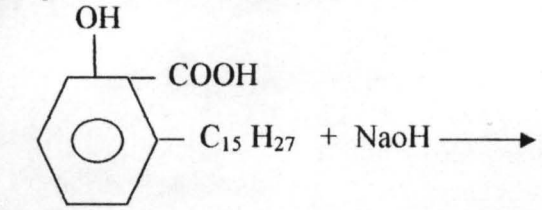
Density $= \frac{6.72 \times 10^{-3}}{7.2 \times 10^{-6}}$

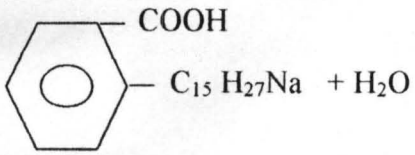
$= 933kg/m^3$

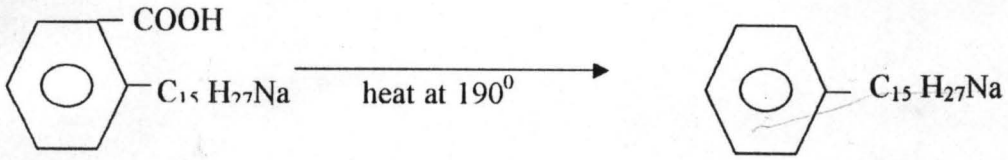
APPENDIX C

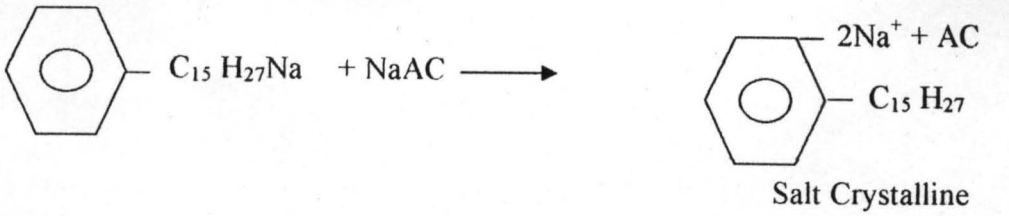
EQUATION AND STRUCTURE OF CNSL

Equations and Formular









Salt Crystalline