Improved Mechanized Fruit Juice Extracting Technology for Sustainable Economic Development in Nigeria

Gbasouzor Austin Ikechukwu, Member IAENG, Okonkwo Chika Anthony

Abstract - The aim of this research work is based on the design and fabrication of fruit juice extracting machine, this machine has the ability to slice and extract juice from fruits and vegetable such as pineapple, orange, mango, apples, passion fruit, tomato, aloevera, awla and grape with the help of the slicing blade, screw conveyor, electric motor, gear train, conical resistor and bearings. The efficiency of the machine is 67% output and the throughput of 4.8 litres/Min. The machine have a sturdy construction and are unique, portable in design and it is made to be a table top machine covering a space of 500mmx 300mm it can be use for domestic and commercial purposes.

Key word: Extracting, slice, conveyor, sturdy, conical resistor, fruit juice.

I. INTRODUCTION

Extraction is a process by which substance are removed for their original component or raw state. Hence, Extraction of juice (juice extraction) may be defined as the removal of juice from fruits; the juice is separated from the skin or chaff.
To achieve juice extraction, force is needed and the force depends on the biological nature and structure of the fruit from which the juice is to be extracted.
The pineapple fruit needs more force than other fruits for extraction because of its thickness of fruit skin. Fruits like banana need lesser force because of it light skin nature. The fruit should be washed thoroughly and pretreatment should also be carried on fruit, proper filtration should be done on juice after extraction.

A. Background

During the early age, juice extraction was done manually by the means of mouth sucking and hand squeezing. The storage of fruits does not last long due to lack of preventive measures, hence fruits were only available for consumption during harvest season. With this situation, there were no extraction and preservation of fruit juice for future uses. In today's world, pollution and chemicals come at us from all angles; our water contains toxic levels of metals and chlorine; our produce is tainted with pesticides; and our meat and meat products are pumped full of hormones and antibiotics
It is small wonder that so many of us fall prey to chronic ailments and disease. So much so, that conditions like allergies, PMS, and migraines have become of common as a cold or the flu.

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In order to live a healthy and vibrant life in today's modern, fast-paced world. It has become absolutely critical to drink, eat consciously biodynamic or organic whenever possible; freshly squeezed juice from fruits and vegetables are excellent source of minerals and vitamins that catalyst chemical reactions occurring in the body. These enzymes also produce the energy needed for digestion, absorption, and conversion of food into body tissues. An increased in take of fruit and vegetable juices ensures that the body will efficiently absorb more minerals and vitamins. Another helpful benefit of fruits and fruit juices is their ability to promote detoxification in human body. Fruit help to cleanse the body, especially those with high acid level. Tomatoes, pineapple, and citruses such as oranges, red grapefruits, and lemons are known for their detoxifying properties. While these fruits promote cleansing, they still provide the body with a high boost of vitamin C! Unfortunately, there are many people who do not eat sufficient quantities of fruit and other fresh produce on a daily basis- or even on a regular basis. This can lead to a lack of nutrients in the body that can have widespread ramifications on the whole body and your health. Fruit provides you with many great things for the body. Fruits have a lot of vitamins like A (especially apricots and contaloupe) and vitamin C (especially citrus fruits like orange and grapefruit).
These two vitamins help heal cuts, assist night vision and create beautiful skin. They are also high in fibre. Fibre helps the stomach digest food and may help to reduce cancer. Most fruits have little fat.
The antioxidants present in the fruits also helps to protect the body from radical because high level of free radicals contribute to heart disease and some of the sugar present in these fruits are glucose, sucrose, and fructose with pre-dominant sugar varying in different fruit (Steminetz. K. A, Potter. J. D, vegetable fruits and cancer, epidemiologist mechanism, cancer causes)
All of these components are necessary in the building of optimum health and success, as well as combating and preventing illness and disease.
In the design and fabrication of the fruit juice extracting machine, careful selection of the most suitable materials are major concern. The skills knowledge and understanding of the importance of hygiene is also a valuable factor. These factors call for selection of material, manufacturing and processing of the juice in order to increase the production quantity, reduce time and labour, also avoid food contamination.

Table I: The sugar content of some ripe fruits.

S/N	Fruits	Glucose	Fructose	Sucrose
1	Pineapple	2	1	8
2	Orange	2	2	5
3	Grape	8	8	0
4	Apple	2	6	4

B. Problem Statement

Fruits are seasonal, they are not available throughout the year. Hence, the need to construct or fabricate a machine that can extract juice in order to enable availability and storage at all time. Establishing good and efficient design of the machine has been matter of concern. As the demand for fruit juice consumption increase from time to time around the globe, the need for designing and constructing a fruit juice extracting machine with high efficiency becomes necessary,

C. Significance of Research

Increase technology development and self-reliance of youths in Nigeria. Create self-development, self-worth and also enhance conversation of human energy, hence increase income.

Eliminates food poisoning and contamination by the use of corrosion resisting materials create employment for the skilled, semi-skilled and unskilled youths of this country.

D. Scope of Research

The scope of this research work ranges from:

- Proper material selection to ensure quality product.
- Proper measuring, cutting and welding of joints
- Proper assembling of parts for construction of machines
- Selection of juice yielding fruit to ensure optimum / proper running efficiency.
- Carrying out of machine analysis.

E. Limitations

This machine was designed mainly for the extraction of juice from succulent fruits like pineapple, orange etc. It cannot be used for extracting oil from oil bearing fruits or seeds like banana and mangoes etc. The machine is designed for squeezing of fruit not for pressing that is why fruits like mango and banana are not to be juice with it.

II. THE ECONOMIC IMPORTANCE OF FRUIT JUICE EXTRACTOR

The citrus fruit juice extractor introduced in the early 40's commenced prior to the world war. The completion of the development was taken over by the central engineering laboratories in Tempe, Arizona. According to Akpan justice. C. (2006) and Udomah Kingsly.S (2010). The first twenty four head rotary fruit extractor was completed in the mid 1946 after the completion it was experimented and tested with citrus fruit at the Sunkist exchange plant also in Tempe, Arizona. Operating problems encountered were noted and corrected and after the correction. The success obtained was encouraging.

In 1947 based on this encouraging performance, three more units were manufactured and operated commercially on orange at the Sunkist outaries California plant during the spring of 1947. Performance of these units was quite satisfactory and sufficiently encouraging.

In 1958, the pre-finishing arrangement was further perfected. This improvement involved the addition of the split in to be used with the orifice tube, which provided pressure in the pre-finishing system. This improvement made possible if reduced diameter strainer tube internal bore during each stroke of the extractor, assuming maximum efficiency under operating conditions. Note the orifice discharge tubes at bottom which remove core membrane and seeds from juice at the moment of extraction. According to Akpan Justice.C. (2006) and Udomah Kingsley.S. (2010).

A model 49' 5" cup heated machine was produced in 1964 to handle the major portion of the grape fruit which was produced in 1958. Another extractor in the 91' model series was introduced on 1972 this unit known (3-318') cups suitable for processing the smaller size line, then in 1972 a plant in Brazil designed and constructed a 100" extractor and that market the beginning of refining program. The previous models were redesigned to encompass the following changes

The adoption of the top loading lower cutters to reduce the time required changing the components.

The covers were changed to fiberglass or stainless steel

A stainless frame and cast stainless and two sides leg members. This change was made primarily to permit use of caustic cleaners to enhance cleaning and improve components life.

All exposed aluminum parts not changed to stainless cleaners.

The feed hopper designed was improved in 1976 to move efficiently transfer fruit, fruits from the tilted feed belt to a feed hopper while this modification was of importance to all model extractors. It was of greater value to the efficiency of high speed machines because of the grantor volume (up to recycle peel oil recovery systems) of being processed.

Extra improvements were done on the machine by using gear trains instead of the belt drive. As can be seen from the initial inline underwent three major model changes which were designated as the 91' series than the 91A' series and the 91B' series. Even though some similarity in appearance to the original machine remains, it is obvious from the many mechanical changes that this extractor has been substantially improved from the data it was manufactured.

Again, the fruit juice extractor and sterilizer currently being designed with the aim of improving fruit juice extractor sterilizer. The machine durability, versatility and capacity were the main concentration and also they solve all defects and limitations forced by fruit juice extracting machines available in the market. In today's market, there are various brands or types of extractors available for the buyer or customers. From a market survey carried out the prices varying slightly different from market to market while departmental stores are more expensive.

A. Types of Fruit Juice Extractor

Continuous Crushing Process Using Cam

The continuous crushing process was introduced during a science and engineering exhibition in Europe. It consists of the hopper, power unit, cam, follower and metal crusher with nail.

In order for the continuous crushing process machine to extract juice from orange or pineapple, it exerts impact shear and compressive force. The metal crusher incorporated in the machine crushes continuously the fruits that are fed into the machine by crushing it against a metal surface which separates the juice which is collected through a special opening. The wastes are forced out through the waste collector.

The motion of the metal crusher is achieved by the use of cam and follower, which is connected to an electric motor by the means of belt and pulley. The motion of the cam and the follower is such that it converts and transmit the rotating motion of the motor to reciprocating motion of the crusher.

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Its advance design is done using a gear instead of the belt and pulley.

The Basket Press

The basket press consists of a horizontal perforated cylinder, a hinged cover, piston with circular plate, paddle, a hydraulic system or mechanical press and a power unit.

The basket press needs to exerts impact shear or compressive force in order to extract juice, the incorporated paddle exerts both impact and shear force on the fruit. This is achieved as the paddle agitates the fruits, it hits and rotates them continuously, introducing a shear and impact force on the fruit. The mesocarp is then softened and separated from the skin. Compressive force can now be exerted by the hydraulic system. The piston force the fruits against the basket and the result is the juice being compressed out of the mesocarp.

The Continuous Screw Process

The continuous screw process consist of the conical barrel, the hopper, the screw shaft, thrust bearings, and the power unit. The force needed to extract juice from the fruits are applied by the screw shaft. The screw shaft also conveys the fruit and waste to the outlet hence, this process is a continuous process.

The screw shaft which is a mechanism device consist of a cylindrical or conical body around which is formed a spiral rib or thread impact and shear forces are applied on the fruits as the screw conveys them forward. Since the process is continuous, thee screw shaft units the fruits against the wall and also rotates them along. The fruits are moved forward in a manner similar to that in which prevented from rotating receive translator motion (advances) when the screw fitted into it is turned. In this case the fruits are prevented from being turned with the screw due to their weight and the friction between the fruit and the walls of the barrel.

Compressive forces are applied by the screw on the fruits against the wall. Due to the conical shape of the collector as the fruit moves down the length of the machine, thus the fruit movement shows down towards the outlet producing a compressive effect on the fruits due to gradual decrease in barrel diameter.

The continuous screw process is chosen in preference to all others because it is cheap to produce. Moreover it requires less labor since it operates on a continuous means.

B. Fruit Juice Extracting Machine Cocoa Juice Extractor

This semi-continuous cocoa pulp extractor has a horizontal cylinder. The rotation blades are mounted on the central axis and this remove pulp seeds. The machine has a through put of 99-180kg per hour.

Fruit Presses

The fruits placed into the machine through the hopper. A handle attached to the machine if turned, presses the fruit and extract the juice.

Hydraulic Vine Presses

This is manually operated by a press and it extracts juice from the fruits through the hydraulic pressure.

III. DESIGN OF THE FRUIT JUICE EXTRACTING MACHINE

In this design of fruit extracting machine in this work many things were considered when analyzing the system.

A. Parts Design and Material Selection

Manufacturing processes includes the processes involved in using various construction methods in producing the extracting machine. In manufacturing, the principal common characteristics is that something physical is being produced or created i.e. output consists of goods or machine, which differ physically.

Manufacturing therefore requires some physical transformation or a change in utility of resources. The parts are different components that when assembled make up the unit in such processes care precision should be the top most priority when carrying out the construction. As far as the selection of material for the construction of machine component and parts is a vital aspect of design.

Various manufacturing processes were carried out during the fabrication, production and assembling of the components parts of this machine in order to be producing the required or particular goods.

The processes involves in producing the machine are as follows:

- Marking out operations or procedures
- Cutting operations or procedures
- Assembling operations
- Welding operation
- Machining operation

Marketing out Operations / Procedures

This is done to get the required shape and size of the design according to our dimensions in order to meet out expectation or aim. It is done or carried out by using tapes, marker, squares, vernier caliper etc.

Cutting Operations / Procedures

- Power saw: for cutting of thick pipes and circular bars.
- Hacksaw: for cutting of rectangular plates and circular bars.
- Emery cloth: for smoothing and polishing of rough edges of wood.
- Chisel and hammer: for cutting of casing of the extractor unit
- Guillotine machine: for cutting of mark out shit of stainless steel and mild steel into the required dimension or measurement.

Assembling Operations / Procedures

This aspect is bringing together of all required part components to form a unit or a complete machine.

Welding Operations / Procedures

This process is the system of using electric welding and electrode to join the art material in to shape

Machine Operations/ Procedures

The operating shaft is machine using the lathe to get the required diameter of the shaft. The machining operation is also adopted for the manufacture of component.

These are listed below:

- Grinding operation

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- Turning operation
- Milling operation
- Drilling operation

Grinding Operation
This operation is a high precision metal cutting operation done with an abrasive grinding wheel, and the milling cutter. This operation is applied during the finishing of the work.

Turning Operation
Is the process of machining round stock on a turning machine, it is a process by which work piece rotates a fixes tool and the most common turning machine is the lathe. Turning operation turned main shaft, which is the extractor shaft to the required diameter in the lathe.

Milling Operation
The milling operation is used in machining which removes metals by feeding the work piece against the rotating cutter. This was carried out to the milling machine, and its application was made use of in manufacturing gears, main shaft, key ways, plunger's teeth etc.

Drilling Operation
The drilling operation is the process of making hole and also enlarging existing hole. Drilling is used to make hole in the filter chamber and some of the work frame and also the position of some parts like electric motor, collecting tank, and gears etc.

B. Material Selection and Components Used
The following are the materials selected for the components of the machine being produced.

Stainless Steel
The shaft, filter and outer chamber, hoppers and conveyor are made of stainless steel.

Properties of Stainless Steel

- It is hard and strong substance
- It is not a good conductor of heat and electricity
- It has high ductile strength
- It does not get oxidized easily
- It is highly resistant to corrosion
- It is capable of retaining its strength.
- It possess magnetic permeability

The Feed Hopper
This is where the fruits are being put into the machine, the feed hopper is made of stainless steel.

The Slicing Blade
The slicing blade is made of stainless steel and is used to cut the fruit into smaller portion before going to the conveyor or screw conveyor.

The Conveyor Shaft
It is a solid circular and made of stainless steel that carries the die (blade) that do the cutting through the rotation of the shaft by transmission of power from the electric motor through the help of gears. It has a length of approximately 560mm and hinged at both ends by a house of bearings.

The Juice Collector
The juice collector is made of transparent glass and is used to collect juice from the filter chamber and it is located under the cylindrical chamber.

The Waste Collector
This is a channel where the chaff is being collected by opening the slab lock for the chaff to fall off into a collector chamber.

The Electric Motor
The motor supplies power to the gear which transmit power to the rotating shaft. The motor has a speed of 1250 rpm and a capacity of 5kw.

Gear Train
The gear train to transmit power from the electric motor to the shaft that rotates the cutter and conveyor.

Advantages of Gear to Belt Drive

- It transmit exert velocity ratio
- They transmit large power than the belt
- It has high efficiency
- It has reliable service
- They have compact layout.

The Barrel
The filter inside the barrel/cylinder of the pressing section is used to separate the juice from the chaff when pressed.

The Ball Bearings
The bearings are used in order to prevent the shaft from wobbling. The bearings used are ball bearing and they are four in number, and coupled to the shaft at both ends.

The Main frame
The main frame is made of mild steel. It supports and carries the weight of the machine and its components.

Outer Cylindrical Chamber
It is built or constructed with stainless steel and contains the shaft that carries the die extracting. It is the cylindrical chamber where the grinding is done and it has a length of approximately 700mm.

C. Operation of the Extracting Machine
After the preparation of the fruits, which involves the peeling and slicing of the fruits, the machine is now being powered on through the control switch that powers the motor and the sliced fruit is being fed in through the hopper. The shaft powered by the gear train rotates anti-clock wise and the slicing blade will slice the fruit and send it to the conveyor where the squeezing will take place through the help of screw conveyor and the filter chamber helps filter the juice from the chaff.

The juice now passes through the hole of the cylindrical chamber of the conveyor and through the filter chamber then enters the juice collecting tank while the chaff moves to the barrel where they fail into the chaff collector.

The machine is a continuous process that is, the feeding of fruit, squeezing, extracting and drawing of chaffs are done continuously.

Fruits Juice Extractor Description

The juice extracting machine consists of various components and its will be great important to have the detailed description illustrated below:

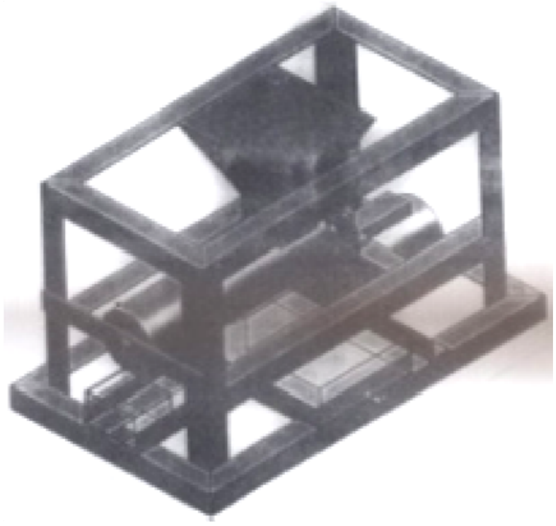

Fig. 1: The Designed Fruits Juice Extracting Machine

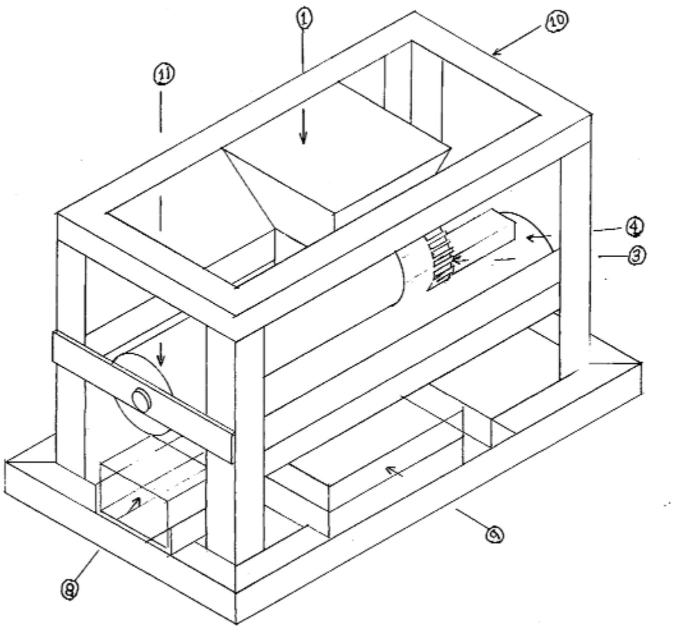

Fig. 2: The technical view of the Fruits Juice Extracting Machine

Table II: Various components of fruit juice extracting machine

Item	Description	Item	Description
1	Feed hopper	2	Slicing blade
3	Conveyor shaft	4	Juice collector
5	Waste collector	6	Electric motor
7	Gear train	8	Barrel
9	Ball bearing	10	Main frame

Pre-Treatment of Fruits

The pre-treatment of the fruits are done to obtain an effective extraction of the juice. It is done to meet up the expectation quality and taste being needed. The processes involved in the pre-treatment are:

Fruit Selection

The fruits that are being selected are fresh fruits in order to obtain a high quality fruits juice. A small quality of bail fruit may change the taste of the whole batch of the juice extracted.

Washing

The fruits should be washed with clear pure or chlorinated water to prevent dirt or unseen micro-organisms before extracting for good healthy juice.

Fruit Preparation

This process involves the peeling and slicing of the fruit under the most hygienic conditions. Plastic or wooden table should be used to avoid contamination of the fruits by germs.

IV. DESIGN ANALYSIS OF THE CYLINDER CHAMBER

Given

Length of the cylindrical chamber = 25cm

Diameter of cylindrical chamber = 9cm

Volume of the cylindrical chamber = R2L

Consider

R = radius (1)

L= length

R=d/2

L=0.25m

Substituting the value

$V = R^2L$

$V = m^3$

Drive Mechanism

Suppose

Diameter of motor gear (D) = 4.3CM

DIAMETER OF MACHINE GEAR (Dc) = 12CM

Motor speed (N_1) = 1250 rpm (2)

Machine speed (N_2) =X

Recall that

$$N_2 = \frac{N_1 D_1}{D_2}$$

N_2 = rpm

Torque developed between the rotating shaft = Fc x R

Fc = centrifugal of rotation = MW^2R (3)

Where

M= mass of rotation

N= radius of rotation

W= angular velocity of rotation

$$W = \frac{2\pi N}{60}$$

M = w/g

Where

G= acceleration due to gravity

M = mass of shaft, gear, and conical restriction on shaft.

Total weight of these components are estimated at75kg

The weight of fruit processed is estimated at 5kg

Total weight = 7kg + 5kg = 12kg (4)

M = w/g = 12/9.81 = 1.22kg

Recall that

Fc = MN2R

Fc = 1.22 x (46.92)2 x 60mm

= 161148.8045

=161.15N

Torque T = fc x R

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$= \frac{161.15 \times 60}{1000}$

$= 9.67N/M$

Power Developed

$P = T \times W$ (5)

Substitution

$P = 9.67 \times 46.92$

$= 453.7$ watts

$P = 453.7$ watts or 0.45 kw

Recall that

1 hp = 750 watts

$X\ hp = \frac{453.7 \times 1}{750}$

$= 0.6hp$

Motor power for our design is 0.6 hp

I. BENDING MOMENT AND SHAFT DESIGN

The schematic representations of force acting on the shaft are as follows.

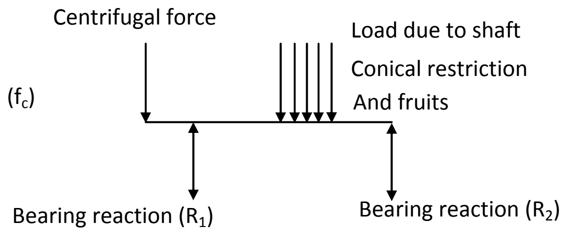

Fig 3: Load due to shaft

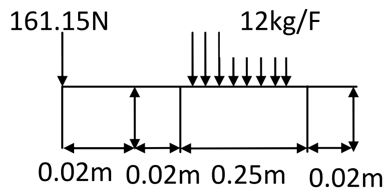

Fig 4: Force acting on the shaft

Recall

1kg/F = 10N/M

12kg/F = 120N/M

Therefore 50N/M =45N

120n/m = XN

$XN = \frac{120N/M \times 45N}{50\ N/M}$

$= 108N$

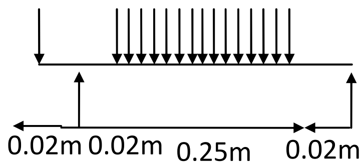

Fig 5: Load distribution change

For ease calculation the distribution local will be changed to a point load

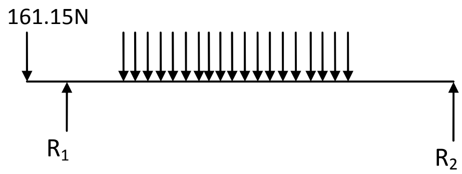

Fig 6: Torque developed rotating shaft

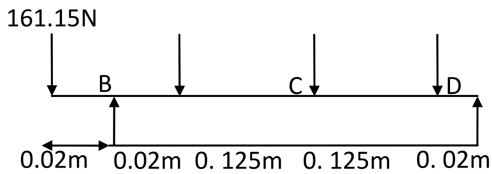

Fig 7: Upward and downward balance of the force

Upward vertical force must balance downward vertical force

$R_1 + R_2 = 161.15 + 108$ (7)

$R_1 + R_2 = 269.15$

Taking moment about D

$-(161.15 \times 0.31) + R1 \times 0.29 - 108 \times 0.125 = 0$

$= -46.86 + 0.29\ R1 - 13.5 = 0$

$R_1 = \frac{60.36}{0.29} = 208.13N$

$0.29rl - 60.36 = 0$

Substituting into

$R_1 + R_2 = 269.15$

$208.1 + R_2 = 269.15$

$R_2 = 269.15 - 208.13$

$R_2 = 61.02N$

Representation of the shaft with all forces we have

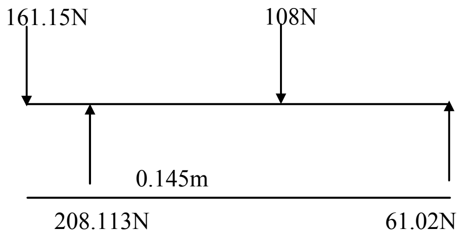

Fig 8: Bending moment of the shaft at maximum

Maximum bending moment, of shaft moment A to B

$M_{A\text{-}B} = -161.15 \times 0.02$ (8)

$= -3{,}223$ N/M

$M_{B\text{-}c} = 161.15\ (0.02 + a) + 208.13\ (a)$

Where a = 0.145 M

$M_{B\text{-}C} = 161.15\ (0.02 = 0.145) + 208.13\ (0.145)$

$= -28.30 + 30.179$

$= 1.979N/M$

$M_{C\text{-}D} = 161.15\ (0.165 + a) + 208.13\ (0.145 + a) - 108\ (a)$

$= 49.957 + 60.358 - 15.66$

$= 5.26$ N/M

The maximum bending is at moment C.D with value 5. 26 N/M

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Bending Moment Diagram

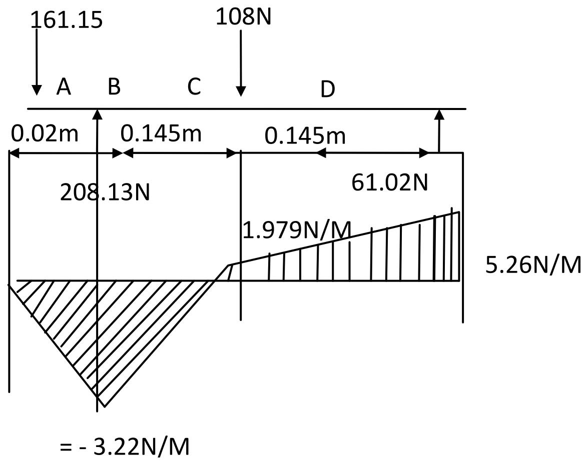

Fig 9: Shaft bending moment

A. SHAFT DIAMETER

Formula for shaft diameter

$D = \{\frac{32n}{\pi} (Km.\ Mmax)^2 + (Kt.\ T)^{2)1/2}\}^{1/3}$

Where

Km = combined stock and fatigue for bending = 1.5

Kt = combined stock and torque for tension = 1.0

Mmax = maximum bending moment = 5.26N/M

T = torque = 9.67N/M

N = factor of softy = 1.0

$D = (\frac{32 \times 1}{3.142} (1.5 \times 5.26 \times 1000)$

$D = (10.184 (62252100 + 93508900)^{1/3}$

$D = (10.184 (62252100 + 93508900)^{1/2})^{1/3}$

$D = 10.1846 (155761000)^{1/3}$

$D = (10.1846 \times 12480.42)^{1/3}$

$D = (127108.0855)^{1/3}$

D = 50.28mm

B. Pressure Developed At The Conical Restriction

Area of the cylinder section (10)

$Ac = 2\pi RL$

= 2283.142 x 0.09 x 0.25

= 0.141 39

$Ac = 0.14m^2$

Area of cone inside $Ak = \frac{\theta x 2\pi 1}{360}$

$\frac{\sin\theta}{2} = \frac{Opp}{Hypo}$

$\frac{\sin\theta}{2} = \frac{r}{r} = \frac{90}{250}$

$\frac{\sin\theta}{2} = 0.36$

$\frac{\theta}{2} = \sin^{-1} 0.36$

$\theta = 2 \times 21.1 = 42.2^0$

$Ak = \frac{42.2}{360} \times 2 \times 3.142 \times 0.25$

$0.184m^2$

Pressing area = Ac – Ak (12)

= 0.14 – 0.184

$= -0.044m^2$

Pressure developed in the barred (13)

$P = \frac{force}{Effective\ area} = \frac{235.14}{0.044}$

$= 5344.09N/M^2$

$= 5.34KN/M^2$

C. CONVEYOR DELIVERY VELOCITY

Conveyor's delivery min = rpm x pitch (14)

Pitch if design = 100mm

$N^2 = 447.9rpm$

Delivery rate = 100 x 447.9

= 44790mm/min

Therefore

$\frac{Velocity}{60} = \frac{44790}{60}$

= 746.5 mm/sec

= 0.7465m/sec

D. BEARING SELECTION

Ball bearing is being used for this design because of the following.

- They can be able to withstand thrust action in the machine
- It serves as means of transferring loads between rotating area and stationary machine member.
- They can accommodate both radial and thrust load.
- They are easy to repair and assemble.

GEAR TRAIN VALUE

N_1= speed of gear (driver) in rpm

N_2 = speed of gear (driver) in rpm

T_1 = number of teeth on gear (driver)

T_2 = number of teeth on gear (driver)

SPEED RATION $= \frac{N_1}{N_2} = \frac{T_2}{T_1}$

Recall: the ratio of the speed of the driver to the speed of the driver is known as train vale of the gear train.

Train value $= \frac{N_2}{N_1} = \frac{T_1}{T_2}$

Where

N_1 = 1250rpm

N_2= 447.9 rpm

T_1 = 22 teeth

T_2 = 65 teeth

Train value $= \frac{447.9}{1250 \times} = \frac{65}{22}$

$= \frac{29113.5}{27500}$

= 1.059

Train value = 1.06

Notice: Belt or Rope has a slipping factor on transmission of motion or power between two shafts. And effect of this slipping is due to velocity ratio of the system. Gear tooth helps in avoiding slipping on frictional wears.

V. TESTING AND ANALYSIS

Testing and Evolution were carried out at the Completion of the construction of the fruit juice extraction machine. The tests were carried out at the designed operation speed of 125rpm.

However, the tests were carried out so as to determine the following.

- The rate of extraction and capacity of machine.
- To determine whether there is leakage in machine.

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- To determine the hours or minute per hour the machine can operate.
- To determine the percentage and the efficiency of the machine.
- To determine number of hours, the operator or engineer can operate on it, in order to know the accurate time to dismantle the conveyor or conical restriction section.

Table III: Determination of the Machine

Tests No	Operating time (mins)	Name of the fruit	No of Fruit	Output (litres)
1	7	Pineapple	5	3
2	13	Pineapple	7	4.5
3	17	Pineapple	9	7

Thus the number of pineapple that can fill in the filter cylinder is twenty one (21) pineapples, output of about 14 litres machine capacity = $\frac{\text{output (in litres)}}{\text{Operating time}}$

Total quantity of juice extracted = 14.5 litres
No of tests = 3
Machine capacity = $\frac{14.5\text{litres}}{3}$
EFFY = $\frac{\text{Max no. of juice extracted (litres)}}{\text{Max. No. of pineapple}}$
= 14.5/21 = 0.69 = 69%

VI. CONCLUSION

This research work has successfully presented a functional and highly efficient low cost fruit juice extracting machine by minimizing local technique of squeezing and sucking of fruits, hence improving the hygienic and health condition of individuals and maintain fluid balance in the body.

The machine can be used for fruit juice drink, soft drink, in restaurant, brewel and bakery industries. The machine is also design for home and industrial usage. The machine is versatility, durability, and the capacity were the main area of concentration.
Though after the design and fabrication of the machine, some lapse were notice the machine could not remove all fruits sediments after extraction and requires further filtration. Some of it's components were manufactured locally, it can be easily fabricated, reproduced and maintained without fear of spare part during maintenance.

VII. RECOMMEDATION

From the project, performance test and result analysis been carried out, modification still needs to be done on the machine in order to increase machines efficiency. The modifications are as follows;
There are some sharp edges on the machine which can lead to injury during operation. Thus, it should be made smoother or the sha1rp edge of the machine should be curved to increase the safety of the machine operator or user.
The conveyor shaft should be made longer so that much of the extraction can be done before3 getting to the withdrawal end as some of the juice out with the roughages.
The waste collector should be made of stainless steel for good food handling because the chaff when dried properly can be preserve or used as flavoring in baking and beverage industries.
The slicing blade should be sharp and made of stainless steel in order to slice the fruit into smaller sizes before entering the conveyor for proper squeezing of fruit. The fruit should be heat treated to kill bacteria to avoid health hazard. Citrus containing PH level less than 4.0 can be pasteurized by heating the juice to 90^0c for a few seconds.
The outer and inner chamber should be more thinner in order to filter the juice and separate the shift from entering the juice collector through the help of the outer filter chamber.

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