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# FABRICATION AND TESTING OF A MOTORIZED TURMERIC JUICE EXTRACTING MACHINE

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## ABSTRACT
*Turmeric (Curcuma Longa) is native of India, it is one of the most important cash crops in India. Processing of turmeric helps to maintain its edibility, palatability and attractiveness. The aim of this paperis to fabricate a turmeric juice extracting machine. The machine consists of: frame, hopper, pulley, auger shaft, cylinder, juice inlet and outlet and electric motor. The machine was run at a predetermined speed of 1400 rpm using 3 mm, 5 mm and 7 mm cone clearance. The weight of tumeric used was 2.0,2.50 and 3.0 kg respectively. The machine was found to have an efficiency of 70%, it was capable of extracting the juice and also separated the chaff. The availability of the machine has made it possible for converting excess turmeric into other usable form during bumper harvest.*

**KEYWORDS:** Tumeric, Tumeric juice, Extraction, Processing and Storage

## 1.0 BACKGROUND OF THE STUDY

Turmeric root and several other species of the curcuma genus wild in the forests of Southern Asia including India, Indonesia, Chine, nearby Asian countries and some pacific Islands including Hawaii. All of these areas have traditional culinary and medicinal uses going back to pre – historic times. Turmeric is eaten as food both raw and cooked throughout Asia. While turmeric root looks much like ginger root, it is less fibrous and it more chewable, crunchy and succulent. The fresh root as has somewhat sweet and nutty flavour mixed with its bitter flavour. Turmeric root also known as curcuma (turmeric in India shaffon, golden goddess) is a perennial herbaceous aromatic plant from the ginger family (zingiberaceae)(Hawkins, 2000, Andersson, 2009, Badmus and Adeyemi, 2004). It is assumed that turmeric originated from China and Buddhist monks in Chinese migration brought it to the India sub – continent. Anyway, Turmeric root is nowadays cultivated in Asian countries (Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesiaand Philippine) and some parts of south America (Peru and Bolivia) but India still remains the largest producers, consumer and exporters. The plant has yellow flowers and reaches a height of about 1 m(Gbasouzorand Okonkwo, 2014, Ryan, 2011).

Tumeric is an underground rhizomeswhich are yellowish, consisting of two long cylindrical branched primary, secondary and even tertiary rhizomes. Tumeric juice is a ready source of vitamins fiber and mineral salt for human consumption due to its uses as medicine, food and appetites (Ashurt, 1991). Tumericjuice is originally produced as a result of surplus production of turmeric tubers, but if is obtained from processing specially grown species for that purpose(Kailappan*et al.,* 2005, Nidhi and Matthew, 2006). In Nigeria, several varieties of perishables and fruits like orange, pineapple, pawpaw, mango, apple, grape, pear and water melon are available in large quantities during their various harvesting seasons. Aikhonbare and Badmus (2003) observed that over 50% of different kinds of fruits

  

produced by fruit farmers in Nigeria are usually wasted yearly due to lack of efficient storage facilities after those fruits have been harvested. In addition to this susceptibility of these perishables to mechanical, chemical and environmental factor contributes to high wastage due to spoilage during the harvesting seasons of such plants.

The only solution to storage problem is the extraction of juice from edible plants. After extraction the juice may be stored in rubber bottle or any other neat packaging, with or without preservative.

According to Kailappan*et al.,* (2005), the most important step in processing fruit juice is selection, extraction, aeration, filtration, preservation and packaging. To achieve this, some researchers in time past have developed machines for extracting juice from fruits among these researchers are Badmus and Adeyemi (2006), Ishiwie and Oluka (2005). Most of these juice extractors are for medium and large scale juice extracion. However, there is need for developing a portable turmeric root juice extractor because it spicy taste that makes so many homes to prefer it to other rhizomes in recent tie, nutritionist in Nigeria began to emphasize on the importance of fruits to the growth of human beings and animals. According to Kintinga and Kadar (1995), fruits act as catalyst when combined with protein in the body to activate the production of some active enzymes, which in turn produce hundreds of important chemical reaction in the body. Fruit and their juices are believed to contain vital food nutrients for both man and animals such as vitamins, minerals and fibres which in turn make fruit and its juices to have medicinal and nutritional values and at the same tine act as appetizers (Ishiwu and Oluka, 2004).

Tumeric juice is used mainly as a preservative in pickles, chutneys, squashes and ketchups. It is also used in pharmaceuticals, aquredic medicines and antiseptic creams. Recent medical research demonstrations in the anti cancer, anti viral activities of turmeric increased its demands (Hoelstad, 2010). Again, rapid growth of population in Nigeria with her elite, gradually discovering importance in demand for fruits and its juices. The demand for different fruits during and out of the season is increasingly high on a daily basis (Bergström, 1994).

Edible plants like tumeric are difficult to keep for a considerable length of time, thus ripe and matured ones are utilized either fresh or processed into juice and special products. Most harvested produce are perishable in their natural state after harvest; deterioration sets in almost immediately due to metabolic activities which continue even after harvest. The perishable nature makes it difficult to store and preserve them; hence there is a gradual loss of flavour and nutritional values. Large quantities of produceare wasted in Nigeria and many other developing tropical countries. It is highly essential to process and preserve the tumeric in order to guarantee regular supply at affordable prices (Hoelstad, 2010).

## 2.0 MATERIALS AND METHODS

### 2.1 Fabrication Consideration

In order to obtain high efficiency and reliability, the machine was fabricated based on the following considerations:

i. The machine should be relatively cheap and be within the purchasing capacity of local farmers/processors.
ii. To prevent turmeric juice from contamination, stainless steel was selected for machine fabrication.
iii. The machine should be made with local and readily available materials.
iv. The screw conveyor shaft was made up of high carbon steel for high tensile strength.

### 2.2 Material Selection for the Components

The machine to carry out extraction operations must attain some special characteristics. Also, the physical, mechanical and chemical properties of the materials selected for such for each of the machine component or unit in the table below. Table 1 shows the material selection for the components.

  

Table 1: Materials selection and components

| S/No | Machine components | Criteria for selection | Most suitable material | Material actually selected | Reasons for selecting the material |
|---|---|---|---|---|---|
| **1** | Machine frame | Must be strong, very rigid, minimizes distortion, able to absorb impact shock | Angle iron | Angle iron | High strength and rigidity, suitable enough to avoid buckling |
| **2** | Pulley | Resistance to wear, strong | Aluminium | Metal | Greater Machine ability and cheaper |
| **3** | Belt | Have elasticity to absorb shock without breaking | Leather | Impregnated rubber | Readily available, safe, adaptable, high allowance stress |
| **4** | Driving and driven shafts | High wear resistance and strength | Carbon steel | Medium carbon steel | Possess high strength and rigidity, suitable enough to avoid buckling |
| **5** | Motor frame | Must be able to absorb impact shock | Angle iron | Angle iron | High strength and rigidity, suitable enough to avoid buckling |
| **6** | Bearings | Ability to hold shafts firmly to avoid friction between moving parts | Steel | Steel | Possess high strength and rigidity |
| **7** | Extraction chamber | Ability to resist corrosion and chemical reaction with starch | Stainless steel | Stainless steel | Possess high strength and rigidity |
| **8** | Auger | Ability to resist corrosion and chemical reaction with Starch | Stainless steel | Stainless steel | Readily available, safe and adaptable |
| **9** | Discharge unit | Ability to resist corrosion and chemical reaction with Starch | Stainless steel | Stainless steel | Readily available, safe and adaptable |

**2.3 Fabrication of Machine Components**

  

Various manufacturing processes were followed during the fabrication and assembly of the component parts of the machine. These includes marking out, cutting, machining, driving, fabricating, assembling and finishing. After the selection of the appropriate materials for each component, the required shapes and sizes were marked according to the design specification, the marking out tools used for this operations were the tri square, vernier caliper, pair of dividers, scriber and centre punch the measurement was done using the steel rule and the scriber for metal compound. The marked out lines were centre punched at desirable point for easy identification during cutting. All the marked out section on each component were cut to size to the required shapes and size using the necessary tools. The shaft was machined using a lathe machine in other to provide the required diameter. Parts subjected to rotary motion or to fatigue loads were produced by milling using milling machine.

**2.4 Description and Mechanics of Operations of the Machine**

1. **The Main Frame**: This is made of mild steel angle iron of 45 mm x 3 mm size. With length of 580 mm and width of 260 mm. The rectangular angle irons firmly fixed together are welded and it supports the prime mover. The extracting unit, horizontal shaft, it is designed for less vibration while in operation.
2. **The Hopper**: The hopper is designed to feed in a vertical position only. The material used for the construction of stainless steel sheet metal (due to the corrosiveness of turmeric) which readily available in the market. The hopper has the shape of a frustum truncated at the top and bottom having a triangular form.
3. **The Juice Collector**: The juice collector is a unit which collects the juice that has been extracted in the extraction unit. It is made of a stainless folded like a funnel with a stainless steel pipe which allows the flow of the juice that has been extracted from the cashew pulp. It is fixed under the extraction chamber.
4. **The Auger Shaft**: The helical flight on the shaft is made from 2.5 mm thick stainless steel. The helical flight ensures adequate transportation without bending and at the same time, exerts pressure on the turmeric.
5. **The Cylinder:** The cylinder was fabricated from 2.5 mm stainless steel thickness to withstand the effect of the pressure exerted on it by the pressure on the shaft and also to cause the turmeric to release juice content to the last drop. Stainless steel was used to avoid contamination of the turmeric juice. A tray was fixed at the end of the cylinder to discharge the pulp into a collector.
6. **Perforated Screen**: The screen is made up of 2.5 mm stainless steel sheet plate which has hole of 1 mm diameter already made on it. This is so chosen to prevent the small pulp particle to pass through and also to prevent blockage of the juice.
7. **Belt**: Belt is used to transmit power from one pulley to the other. But v – belt are mostly used in domestic factories and workshops where great amount of power it to be transmitted from one pulley to another and where two pulleys are very much nearer to each other.
8. **Discharge Chute**: The discharge chute is a unit where the chaff is being discharge from the machine after the juice has been properly extracted from the pulp in the extraction chamber.
9. **Bearing**: A bearing is a machine element that supports machine elements. It helps to permit a relative motion between the contact surfaces of members while carrying a load.

  

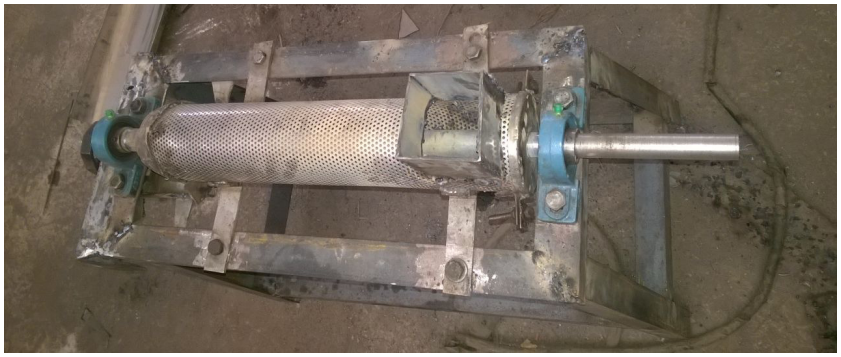

Plate 1: Skeletal view of the frame of the machine

Plate 2: Complete machine after painting

Plate 3: Measurement of the weight of turmeric root

  

Plate 4: Performance Evaluation in progress

**2.5 Principles of Operation of the Machine**

In this fabrication the use of screw press to obtain a large mechanical advantage on a piston's face to crush turmeric root was adopted for juice extraction from turmeric root. The pressure that was made available on the piston's face was greater than the minimum pressure required to cause failure of the fruit so that it will be able to crush it and the juice bearing cells release their contents. As the screw moves steadily along its horizontal axis, the piston's face drags the root against the end plate and increases the pressure to produce a squeezing effect on the turmeric root. Then the extracted liquid flows through the juice outlet.

**3.0 RESULTS AND DISCUSSION**

**3.1 Experimental Design**

In the experimental design, noticeable factors affecting the performance of the juice extractors are:

- The length of extraction unit
- Speed of operation and the outlet chute among others.

It is not certain if these factors will affect the performance of the turmeric juice extractor.

This experiment was designed to investigate the effect of the outset chute on the performance of the turmeric juice extractor. Chute openings of 3 mm, 5 mm and 7 mm were investigated.

**3.2 Performance Test of the Machine**

The turmeric juice extractor was tested in the department of Agricultural and Bio-Environmental Engineering technology workshop Auchi Polytechnic. The testing was carried in two phases. Firstly, the free run (without load) and secondly test with load (that is test with turmeric) a weighing balance was used to measure the quality of turmeric pulp used while a stop watch was used to determine the duration of expelling.

The machine was operated without any load turmeric pulp the machine was set to run freely for about 10 mins to check for malfunctioning and noise or abnormal vibration.

The testing of the machine was carried out using 152. 1069 (QT) of turmeric was gradually fed into the machine while the electric motor was running it was able to press the turmeric and extract the juice. This is an indication of the satisfactory performance and at this state; juice was seen coming out from outlet. While the chaff (pulp) was coming out through the outlet. The working of the machine

  

continues until the entire turmeric was completely pressed. The juice was collected and weighted to be 106.40 g (Qi).

### 3.3 Experimental Procedures

Table 2, 3 and 4 shows the results obtained from the test. The machine was run at a predetermined speed of 1400 rpm using 3 mm, 5 mm and 7 mm cone clearance, a known weight of ginger was fed through the hopper while taking note of the passes and the time taken to obtain acceptable extraction efficiency. The weight of turmeric used was2, 2.5 and 3 kg.

Table 2: Using 3 mm clearance between the chute and the cylinder

| Quantity of Turmeric (kg) | Number of passes | Time of operation (min) |
|---|---|---|
| 2 | 1 | 2.34 |
| 2.5 | 1 | 3.53 |
| 3 | 1 | 4.16 |

The above test was repeated using cone clearance of 5 mm and 7 mm. The result are shown in table 3 and 4.

Table 3: Using 5 mm clearance between the cone and the cylinder

| Quantity of Turmeric (kg) | Number of passes | Time of operation (min) |
|---|---|---|
| 2 | 1 | 1.58 |
| 2.5 | 1 | 2.14 |
| 3 | 1 | 2.55 |

Table 4: Using 7 mm clearance between the cone and the cylinder

| Quantity of Turmeric (kg) | Number of passes | Time of operation (min) |
|---|---|---|
| 2 | 1 | 1.44 |
| 2.5 | 1 | 2.00 |
| 3 | 1 | 2.17 |

### 3.4 Juice Extraction Efficiency

Determination of functional efficiency

$$Efficiency = \frac{Output\ of\ juice\ collected\ at\ the\ drain\ channel}{Total\ mass\ of\ Juice\ in\ turmeric} \times 100$$

Where Qi = Output of juice collected

Qt = The total mass of turmeric

$$Efficiency = \frac{Q_i}{Q_t} \times 100$$

$$= \frac{106.40}{152.106} \times 100$$

$$= 69.79\ \% = 70\%$$

  

### 3.5 Maintenance of the Machine

Maintenance is a compulsory operation which is carried out on the machine in order to make the machine to work throughout its useful life.

Regular cleaning carried out on the machine includes;

i. Regular cleaning to remove any dust particles.
ii. Tightening of any loose bolts and nuts.
iii. Lubrication of moving parts/joints
iv. Adjustment and replacement of worn out parts.

## 4.0 CONCLUSION

This machine was designed and fabricated to extract juice from turmeric, ginger, to reduce the usual wastage during pack harvest on most plantations in Nigeria. The machine has low maintenance cost and replacement of parts can be done with ease because the machine was made from locally and readily available materials.

After a rigorous testing of the machine, it was found that machine has efficiency of 70% is achievable and the machine was capable of extracting the juice and the chaff are well disposed from the chaff outlet. It was observed also that the efficiency of the machine cold be increased by increasing the quality of the turmeric roots fed into the machine.

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