DEVELOPMENT OF A VIBRATORY HONEY EXTRACTOR

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ABSTRACT

Extraction of honey from honey comb is extracted predominantly using either traditional method or the mechanical screw press method which generates a problem of crushing the comb along with the extract. This creates an additional cost of separating unwanted materials in the extract. To solve this problem for stakeholders in the honey business worldwide, a vibratory honey extractor was conceived, designed and fabricate. The machine was made of stainless, mild steel and plastic materials. The machine has a capacity of 2.5 Kw and operates at speed and frequency of 483 rpm and 50 Hz respectively. The machine was able to attain an extract of 98.9% a value far better than the centrifugal method within 40 minutes of operation. A reduction to 0.21 of the initial weight of honey extraction was obtained at an average extraction rate of 7.36g /min. The honey extracted was good quality given the best acceptable value for all stakeholders in the honey business industries.

Keywords: Vibratory; Extraction; Quality; Design; Oscillation

INTRODUCTION

Honey bees economy in the production a natural food (Chopra, 2006) an assets to man (Doug, 2012) were enumerated in Codex Alimentarius, 1989 report**.** The advantage of which is of great and numerous benefits to human health when consumed in replacement to intake of complex sugar (Ola *et al*, 2016). These claims of curative effect and maintenance of good health derived from consumption of honey products were mentioned by (Edger, 2011). More also honey business had being estimated to generate an income in the range of $45,000 to $52,000 annually (Gaby *et al*; 2007). Other reports on honey production such as; Kangave et al (2012); Krell (1996); Root (2005) and Chopra (2006) gave vital economic importance of honey business.
The value of honey, in terms of quality, products being processed in Nigeria either by the traditional method or the screw press methods may not meet the international market value. This fact is due to a lot of unwanted materials being extracted with the honey. Even subsequent attempt to separate this mixture results in increase in the additional cost production while not all of these unwanted materials are thoroughly removed. This in turn affects the final products from these two methods. There is need to develop an indigenous extractor that will match the types of hive predominantly used in Nigeria which is the top Kenya bee hive.

A vibratory extractor was conceived and was desirable for design. An additional desire was to come up with an extractor that will reduce the cost of honey production but of good quality and grade, that could fetch high market value. The cost making the extractor itself must also be low and of local materials available and gender friendly. This development should be acceptable to stakeholders in the industries and a replacement for the centrifugal honey extractor which is beyond the reach of local farmers using the Top Bar Kenya in Nigeria.

Design Concept.
The theoretical principle of the machine operation was to develop a vibratory mechanism having the right amplitude and of a specific frequency that would overcome the energy binding the honey in the comb. In other to do this the energy required must be more than viscosity of honey. The light agitation generated from the scotch yoke forces the honey out

of the comb with minimum or no distortion to the honey comb. The energy required to do this is enumerated in Ola *et al (*2016).

2.1 Design and components parts of the machine

The vibratory honey extractor shown in F igure1 consists of the following; hanger, baskets, extracting chamber, baskets compartment, frame, belt, pulle y, scotch yoke mechanism and electric motor.

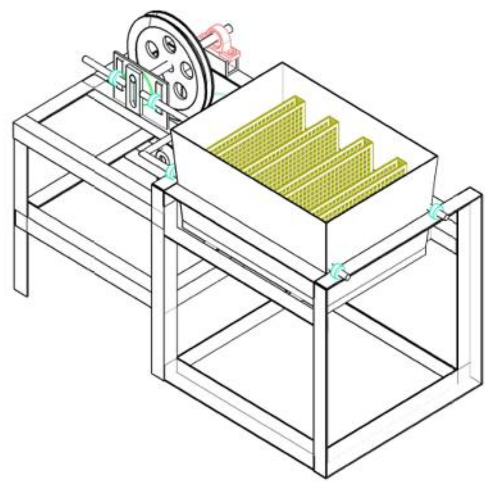


Figure 1: Isometric view of the machine

Component parts description and specifications

The hanger consist of two rod shafts, coated with PVC pipes of 15 mm diameter and of total length 370 mm, for holding the two extreme end of the basket in which the honey comb to be extracted id placed. The basket was made of plastic having several perforations which allows the extract to come out as the whole basket agitates on the hanger shaft. The extracting chamber for holding the honey combs during extraction was made of a 75 liters' plastic trapezoidal in shape. This material was desirable to lower the cost and as well as present a hygienic chamber that would not contaminate the honey being extracted. The frame was made of Mild steel angle iron of 35 mm by 3 mm thick. This provides the necessary support for the whole machine. The mechanism creating the vibratory motion of the extractor was the scotch yoke mechanism generating amplitude of 100 mm and a frequency of 50 Hz. Other component parts ; belt and pulley were the "A" type "FINER" belt of number 12.5X1075A40 and pulley diameter of 200 mm connected to the motor pulley of diameter 30 mm . The electric motor that powers the whole unit was a 2.5Kw.

The full details of the design, material selection and size specifications of all these components are reported in Adewumi (2018).

METHODOLOGY

The extractor designed shown in Figure 2 was fabricated in the workshop of Agricultural and Bio resources engineering Federal university of Agriculture Abeokuta. The machine was tested and found functional. For the initial no load test the parts requiring fine tuning were adjusted to meet up with the expected performance. There are four baskets for holding the honey comb during extraction which was made of stainless steel frame and plastic nets as side guide to hold the comb in the compartment. The basket compartments thickness, height and length were 35 mm, 210 mm and 350 mm respectively. To guide the design and formation of this part are dimensional information of various Beehives obtained from Aslop (2009). Other use parameters used in the design of the machine e.g. speed, viscosity, force and power required were adapted from Ola *et al* (2016).

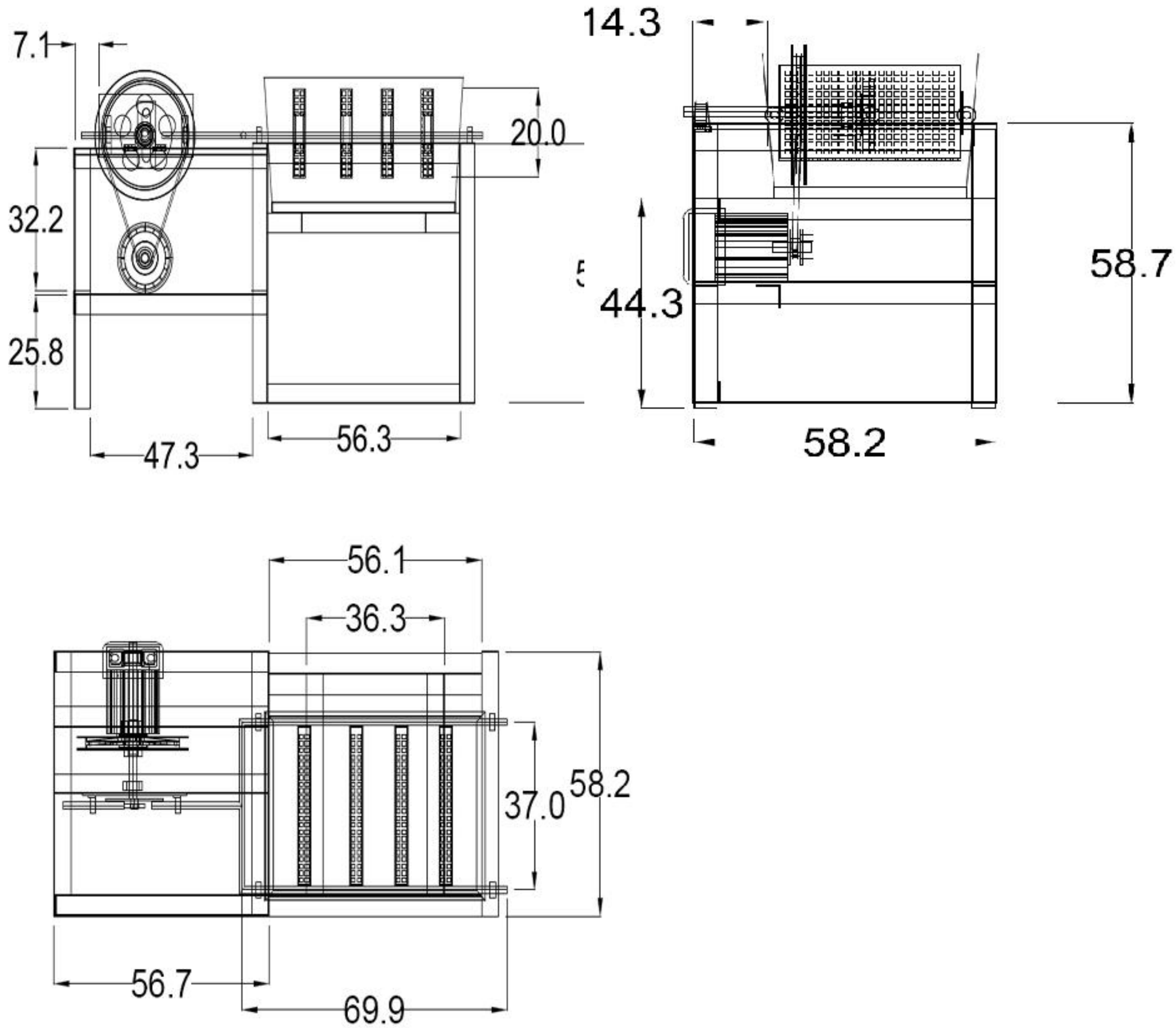


Figure 2 Orthographic projections of the vibratory honey extractor

The power requirement for the extractor was obtained in design based on the total weights of components and material mass being moved by the unit calculated using the basic power deriving equation;

$$P = F \times M_T \times V \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where P = power required to drive the machine

M_T = total mass the machine being vibrated

V = velocity of vibration

A value of $1.29hp\ w$ obtained and use to drive the machine. In determining the frequency of vibration of a desired machine angular speed of 483 rpm (Ola *et al.;* 2016)

From simple harmonic motion,

$$v = w \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where v = Linear velocity of the hanging shafts (m/s)

r = Crank radius (m)

w = Angular velocity of the slider crank mechanism ($r\ /s$)

t = Time of oscillation (Sec)

For maximum velocity, sinwt=0. Therefore

$$v = w \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where

$$w = \frac{2\pi}{6} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$w = \frac{2\pi}{60} \times 483 = 50.62\, r\ /s$$

With amplitude of 70 mm, crank radius (r) = $\frac{A}{2} = \frac{7}{2} = 35$mm or 0.035m

$$v = 50.62 \times 0.035 = 1.77m/s$$

Maximum acceleration (a) at a peak of stroke,

$$a = w^2 r = 50.62^2 \times 0.035 = 89.68m/s^2$$

RESULT AND DISCUSSION

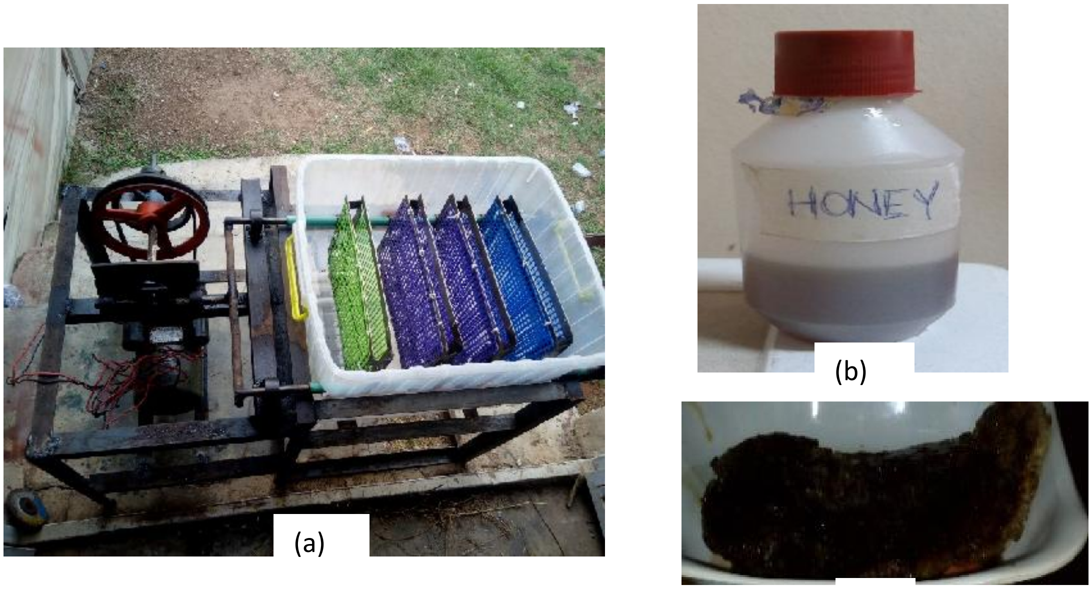
The machine fabricated is shown in Plate 1. It was tested and the result is given in Table 1. The machine was able to extract 98.9% of the mass honey out of the 317.5 g, fed into the machine, within 40 minutes of operation which was 0.21 reduction of the initial weight. The extraction was quite acceptable in terms of quality and quantity to meet up with international standards. It was observed that the extract was free from the unwanted materials; it was crystal clear as shown in Plate 2. An average extraction rate of 7.36g /min was attained during the test of the machine.

Table 1 Variation of extraction efficiency with time for the vibratory extractor

Time (mins)	**Initial weight (g)**	**Final weight (g)**	**Extracted weight (g)**	**Efficiency (%)**
20	317.5	136.06	181.44	57.1
40	181.44	68.05	113.39	64.3
60	68.05	68.05	0	64.3
80	68.05	68.05	0	64.3

Discusion

The extraction test showed that at an angular speed of 483 rpm an extraction 57.1 % is attainable within the first 20 mins. While for the next 20 mins the extraction increases to



(c)

Plate 1(a) Aerial view vibratory honey extractor, (b) Honey extracted and (c) Honey comb.

64.3 % extraction a 7.2% increase. This increase in extraction is as a result of the reduction in efforts required to continue to extract honey from the comb. The initial effort required to break effect viscosity force retaining the honey within the comb is great. This effort continues to reduce as the machine oscillates at 50 rads/sec. The machine was also tested at an angular speed of 300 rpm. Little or no extraction of honey was observed at this speed. This means the more the speed of rotation or frequency of vibration, the more the extraction that will be obtained. Care should be taken since high speed of over 1000 rpm would damage the comb and cause aeration leading to the destruction of the honeycomb.

CONCLUSION

The machine was able to extract honey in the preferred quality and quantity within 40 mins of operation at efficiency of 98.9%. This method is far better than the centrifugal method/ Stakeholders in the honey business can adopt this new method and produce good quality honey that have high market value thereby improving their livelihood.

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