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Performance Evaluation of Indigenous Honey Extractor

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Abstract:

Apiculture is becoming popular and more lucrative in Nigeria, and one of its major challenges is the extraction process of honey from its comb. This study evaluated an existing honey extractor fabricated at the Department of Agricultural Technology of the Federal Polytechnic, Ile-Oluji, to assess its efficiency, productivity, and overall performance. The evaluation was carried out by extracting honey from honeycombs weighing 15 kg, 10 kg, and 5 kg while keeping the extraction time constant at 30 minutes. The results show that the extractor achieved an average extraction efficiency of 87% and a throughput of 0.45 kg/min. The study identified key factors influencing the extractor's performance and provided recommendations for optimizing its operation. It is also recommended based on the findings of this research that the honey extractor evaluated can be produced en-masse for peasant beekeeping farmers. This will greatly benefit the apiculture industry in producing quality honey for consumption and commercial purposes.

Keywords — **Honeycomb, Honey-Extractor, Evaluation, Efficiency, Throughput.**

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I. INTRODUCTION

Apiculture, which is the act of rearing Bees for the production of honey is becoming popular in Nigeria as many farmers are engaging in this arm of agriculture [1]. Honey is produced as a sweet oily food substance from the secretion of Bees which feeds on flower nectar. The honey is kept in the honeycombs which are harvested for its extraction [2]. The benefits of honey range from its medicinal properties to its nutritional value. Various food and health industries use honey as a sweetener and as a major ingredient in health supplements [3]. This production alleviates poverty among smallholder farmers and also creates jobs in various sections of its production processing [4]. One of the basic needs for crop production is pollination and [5] observed that beekeeping plays a vital role in this regard. Nigeria, according to the report of [6] produces about 50,000 metric tons of honey annually, however, [7] discovered that despite Nigeria being one of the countries that consumes honey the most, its production is still low when compared to the increased demand for honey for medicinal purposes. Some of the identified factors responsible for a decline in honey production include the use of the traditional method of scooping the honey from its combs, limited access to modern technology, and reliance on imported honey ahead of the one produced locally thereby forcing the price of the latter down, discouraging the bee farmers to put in their best [7], [8], [2]. Other factors noted by [3] is the lack of appropriate processing factories and poor transportation systems. Reference [1] observed pests and diseases as some of the challenges facing the quality of honey produced.

To produce clean and healthy honey, protect the honeycomb from excessive damage, and mitigate its loss during the scooping, an Indigenous honey

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extractor was fabricated at the Department of Agricultural Technology, Ile-Oluji as shown in Figure 1, which is now subjected to evaluation to determine its efficiency, throughput, and specific mechanical energy.

These parameters will help in the mass production of the machine for the usage of small-scale honey farmers and industries.

Fig.1. Fabricated Honey Extractor

II. MATERIALS AND METHODS

A. Limitation of the Study

This study is limited to the evaluation of the performance of an existing fabricated honey extractor at the Department of Agricultural Technology of Federal Polytechnic, Ile Oluji, Nigeria. The evaluation covered the percentage of the honey extracted from the honeycomb, the efficiency of the extractor, the throughput of the extractor, and the quality of the honey in terms of its moisture content, pH, and presence of impurities. Also evaluated were the ease of operations and the durability of the extractor, which was tested based on its ability to withstand repeated usage without buckling.

B. Study Area

The experiment was conducted at the workshop of the Agricultural Technology Department of Federal Polytechnic Ile-Oluji, Nigeria. The workshop is located within the coordinates of Lat. 7.236935^{o} and Long. 4.861769^{o}

C. Experimental Design

20 kg of Mature Honey Comb (MHC) was purchased from peasant farmers at the Ogbese market of Akure North Local Government of Ondo State. MHC was randomly weighed into three places 15 kg, 10 kg, and 5 kg respectively. These were fed into the compression chamber of the extractor for the extraction of the honey through a 5-ton hydraulic jack.

The pH of the extracted honey was measured by the HI99162 Portable Milk pH Meter. 10 g of honey was mixed with 100 mL of distilled water. This was stirred together and the pH meter probe was fully dipped inside the solution for 2 minutes while the pH was read off the LCD.

The Moisture Content of the Extracted Honey was discovered by using the oven-drying method. 20 g (W_3) which was the initial weight of the EH was placed in a 100^{o}C pre-heated oven for 2 hours after which the weight (W_4) was taken again and the difference calculated.

The parameters measured were;

a) The weight (W_1) of the MHC before compression was measured in kilogram
b) The weight (W_2) of Extracted Honey (EH) measured in kilogram
c) The Time Taken (TT) for the full extraction of the honey from the honeycomb was constant at 30 minutes
d) Honey Extraction Efficiency (HEE) measures the percentage of honey extracted from the honeycomb, which represents the efficiency of the honey extractor
e) The Throughput (TP) measured the amount in kilogram of honey extracted per 30 minutes of honeycomb extraction compression
f) Moisture Content (MC) measures the percentage of water content in the extracted honey

These parameters were calculated according to [9], and [10] from the formula in equations 1 – 3

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$$\text{HEE}\ (\%) = \left(\frac{W_2}{W_1}\right) \times 100 \qquad \text{eqn. (1)}$$

$$\text{TP}\ (\text{Kg}) = \frac{W_2}{\text{TT}} \qquad \text{eqn. (2)}$$

$$\text{MC} = \left(\frac{(W_3 - W_4)}{W_3}\right) \times 100 \qquad \text{eqn. (3)}$$

D. Data Analysis

Descriptive analysis using Microsoft Excel (2013) version is used to analyze the result. Analysis of variance (ANOVA) was also used to test if there were any statistical differences between the means of the three honeycombs used for the experiment. Figure 2 shows the pictorial view of the experimental process revealing the honeycomb, the extractor, the hydraulic jack, and the extracted honey.

Fig.2. Pictures of the Honey Extraction Process

III. RESULTS AND DISCUSSION

The parameters measured and calculated from the data obtained from the experiment are shown in Table 1. The moisture content of the honey was calculated as 16 % and the pH was 5.5 which corroborates Kumar and Kumar (2018) in a related work on the Physico-chemical characteristics of Indian honey.

TABLE I
PARAMETERS MEASURED FOR HONEY EXTRACTOR

Spec	W_1 (kg)	W_2 (kg)	EH (kg)	TT (min)	TP (kg/min)	HEE (%)
A	15	1.45	13.55	30	0.45	90.33
B	10	1.05	8.95	30	0.30	89.50
C	5	1	4	30	0.13	80.00
Average	10	1.17	8.83	30.00	0.29	86.61

E. Honey Extraction Efficiency

As presented in Figure 3, the highest efficiency of the honey extractor (90.3 %) was obtained for the matured honeycomb of weight 15 kg. This was followed by that of 10 kg (89.5 %) and 5 g (80 %). It was observed that for an average of 10 kg of MHC, the average efficiency of the honey extractor was about 87 %.

The analysis of the variance of the mean of the different weights of the MHC showed that the mean extraction efficiency of the honey extractor was significantly higher since p-value = $6.36e^{-05}$ < 0.05 than the reported methods of honey extraction.

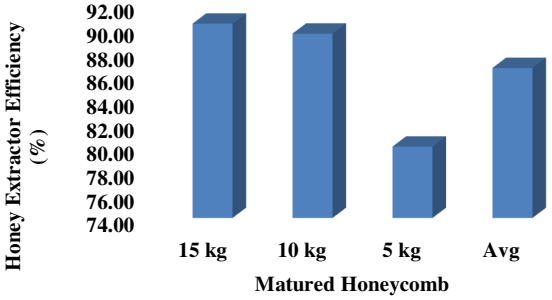

Fig. 3. Honey Extractor Efficiency

Reference [11] reported 86 % efficiency with their mechanical centrifugal spinning honey extractor, while [12] for their mechanical honey extractor reported an efficiency of 82 %, and [13] for their mechanical honey extractor reported an efficiency of 68.16 %. Reference [14] also reported an average of 63 % efficiency in their vibrator honey extractor. The traditional method of honey extraction according to [15] had an efficiency of 56.3 % and 70.6 % for the hand-driven manually operated honey extractor.

The higher mean efficiency (87 %) obtained from this study was as a result of the design consideration which included the compression principle of honey extraction which forces the honey through a perforated cylindrical barrel into a receiver compared to other methods of vibration and spinning. Also was the ease of operation of the extractor.

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F. The Throughput of Honey Extractor

The throughput of the honey extractor, presented in Figure 4 for the 15 g, 10 g, and 5 g of MHC were 0.45 kg/min, 0.30 kg/min, and 0.13 kg/min respectively. For an average of 10 kg of MHC, the throughput was 0.29 kg/min or 4.83 g/sec.

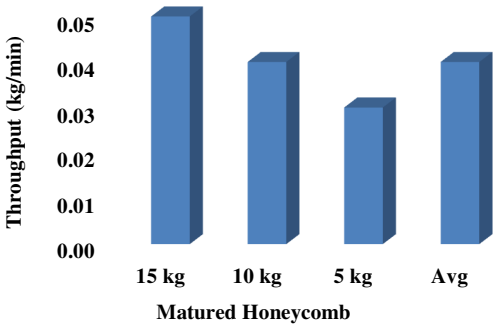

Fig. 4. Honey Extractor Throughput

This result was higher than that of Onwuamaeze and Oyejide (2018) who had the throughput of their honey extractor as 0.0360 kg/min.

G. Analysis of Variance

The analysis of variance (ANOVA) showed that the weight ($P = 6.36e^{-05}$) of the honeycomb and the time taken ($P = 6.89e^{-05}$) for the extraction had an extremely significant effect ($P \leq 0.05$) on the efficiency of the honey extractor as shown in Table II. The effect of the throughput ($P = 2.82e^{-2}$) on the extractor efficiency was equally significant at $P \leq 0.05$.

TABLE II
ANOVA: PERFORMANCE EVALUATION OF HONEY EXTRACTOR

Parameter	*P-value*
Efficiency	6.36E-05*
Time Taken	6.89E-05*
Throughput	0.028285*

*statistically significant at p-value ≤ 0.05

IV. CONCLUSIONS

The performance evaluation of an indigenous honey extractor was successfully carried out at the Laboratory of Agricultural Technology, Department of the Federal Polytechnic, Ile-Oluji. The results show that the extractor is capable of processing honey from the honeycomb at an average rate of 0.29 kg/min, with an average extraction efficiency of 87%. The extractor's performance was influenced by the weight of the honeycomb, the time taken for compression, and the aesthetic design of the extractor for ease of operation.

Based on this evaluation's findings, the machine is recommended to be mass-produced for peasant farmers engaged in apiary farming. Additionally, young graduates can be trained and engaged to produce the machine and assist the peasant farmers in its operations, this will serve as employment for them. It is also recommended that the extraction chamber should be increased to accommodate more weights of honeycomb for large-scale farming.

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