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On-farm Evaluation and Selection of Manually Operated Honey Extractor

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Abstract: ***In the study area, honey is extracted using traditional methods, which leads the product to degradation in nutritional quality and quantity. As a result of this, honey extracted traditionally does not meet international market standards; to minimize this problem several honey extractors are available, but the problem of cost, maintenance place, and durability were the main issues for the farmers. Therefore, the main objective of this research work is to collect and evaluate the performance of available honey extractors and to select a better-performed model. Data like time of extraction (min), mass of honeycomb before and after extraction (kg), and mass of extracted Honey (kg) were collected. Losses (kg), Extraction efficiency (%), and Extraction capacity (kg/hr) were calculated. Simple descriptive statistics were used to analyze data. Accordingly, the mean extraction capacity was 68.28, 62.88, and 56.76 kg/hr, and the mean extraction efficiency was 71.39, 65.83 and 60.31 % for the Imported, Jimma Agricultural Engineering Research Center and Fadis Agricultural Research Center models, respectively. As depicted from the results all extractors have good performance. However, the Jimma Agricultural Engineering Research Center model will be recommended for small-scale holders based on its price, maintenance availability, spare parts, simplicity, and durability.***

Keywords: Evaluation, On-Farm, Manually Operated, and Selection.

I. INTRODUCTION

Honey is the most important primary product of beekeeping both from a quantitative and an economic point of view [5]. The history of the use of honey is parallel to the history of man and virtually every cultural evidence that can be found of its use as a food source and as a symbol employed in religious, magic and therapeutic ceremonies is an appreciation and reference it owes among other reasons to its unique position until very recently, as the only concentrated form of sugar available to human in most parts of the world [7]. They are dependent on pollen as a protein source and on flower nectar or oils as an energy source. Bees generally produce honey mainly from the nectar of flowers, plant saps, and honeydew. Honey is a mixture of sugars comprising glucose and fructose, in addition to water usually 17- 20 %. It also contains very small amounts of other substances like minerals, vitamins, proteins, and amino acids.

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Honey is the main ingredient in alcoholic beverage meal (honey wine or honey beer; typically made with honey and water mixture with a pack of yeast added for fermentation) [8][10][11]. Currently, honey is extracted from honeycomb using traditional methods. The traditional methods of extracting honey lead to a reduction in nutritional value and quality; the unripe and capped honeycomb are collected at night [4]; and the extraction is achieved by squeezing manually with the hand. It involves the use of bare hands with a knife to cut open the comb of the honey before extracting it into a container thereby damaging the honeycomb. After setting the bee comb, put the dry leaves or palm kernel chaff on the caped comb and heat for a few minutes to kill both the queen and the drones. Thereafter, an extracting knife is used to pull off the uncapped comb and then put it inside the bucket or container. After the extraction, the honey is then taken home and pressed with the hands to separate the honey from the residue. The raw honey is filtered with a sieve to remove the remaining particles after this the honey is ready and fit for consumption [6][12][13].

However, the hand contaminates the honey, and unripe honey ferments within a few days after extraction, the materials collected are left untouched until the next morning, and bee-wax which has become hardened at the top of the honey is removed and the harvested honey is later poured into bottles [9]. Generally, honey extracted traditionally does not meet international market standards; to minimize the problem several honey extractors are in the hands of the farmers, in the research center, and on the market, but the problem of cost, maintenance place, and durability were major issues still for the farmers. Therefore, there is a need to select the better-performed honey extractor by considering cost, durability, and maintenance place availability. The main objective of this research work was achieved by evaluating the performance of honey extractors and selecting better models from Fadis Agricultural research Center, Jimma agricultural engineering research center, and imported models [11][13].

II. MATERIALS AND METHODS

Three types of honey extractors (Fadis Agricultural research Center, Jimma agricultural engineering research center, and Imported model Honey Extractor) were collected from their respective source. The evaluation of the machines was done at a beekeeper's home. Boko and Grawa Districts were selected purposively. Honey extractors, digital balance, modern beehives, stopwatches, and beekeeping safety materials were materials and instruments used. Simple descriptive statistics were used to analyze the collected data.

Figure 1: JAERC, Imported, and FARC Model Honey Extractor Respectively

III. OPERATION PRINCIPLES OF HONEY EXTRACTOR

The machine operates by the principle of radial motion of the basket inside the drum. All of the collected honey extractors were made of an axial solid shaft carrying the gear driving system on the topmost part. This solid shaft accommodates the triangular-shaped basket which holds the matured honeycomb ready for extraction. The mechanism was housed in a galvanized stainless steel cylindrical container for honey collection and withdrawal, the driving mechanism that gives the machine drive consists of a gear, shaft, and handle which transmit the motion from the handle to the shaft, connected to the shaft that always drives the basket inside the drum due to the gear mechanism incorporated. The basket was loaded with matured honeycombs, and the metal basket was turned to rotation by force on the handle. As the centrifugal force increases, the rate of honey outflow increases until the combs are empty of their honey. The extracted honey flows down by gravity into the collector for collection

Uncapped frames full of honey were loaded into the cage (frame holder) and then spun, as the cage with the frames spun inside the extractor tube, centrifugal force caused the honey to be flung out against the walls of the tube, then pure honey runs down to the bottom where there is a honey gate valve to drain the tube.

IV. SAMPLE PREPARATION

A sample of the honey was followed at the farmer's home level via district experts and the farmers as well to inform the maturity stage. Fully matured honey was used for the test of the machine by scraping the shielded (sealed) face to facilitate the throw ability against rotation. During the trial, the farmer worried that the availability of maintenance place and the price of the honey extractor were the major. Since the extractor on the hand of the farmer was the imported model, for this reason, the spare part was not available nearby so they threw it without taking any measures.

A. Data Collected

Extraction time (hrs), weight of comb before extraction (kg), weight of comb after extraction (kg), weight of extracted honey (kg), and losses (kg).

B. Performance Evaluation of Honey Extractor

Extraction efficiency and capacity of the machine were computed using the following equations [1]

C. Capacity of Machine (kg/hr.)

$$C = \frac{MEH}{ET}$$

D. Efficiency of Machine (%)

$$EE = \frac{MEH}{TM} * 100$$

Where:

C = Capacity of machine Kg/hr)
MEH = mass of extracted honey (kg)
ET = Extraction time (hr)
TM = total mass before extraction (Kg)
EE = Extraction Efficiency (%)

V. RESULTS AND DISCUSSION

Accordingly, three of them were evaluated to extract the honey from the comb without destroying the comb, so the results obtained were presented in the form of a table and narration as follows.

Table 1: Result of the Performance Evaluation of Honey Extractors

Extractors	MBE (kg)	MAE (kg)	MEH (kg)	L (kg)	ET (min)	ŋ (%)	C (kg/hr)
Imported Model	2.49	0.52	1.86	0.11	5	71.39	68.28
	2.32	0.51	1.61	0.20			
	2.19	0.56	1.53	0.10			
Mean	2.33	0.53	1.67	0.14			
FARC Model	2.43	0.71	1.48	0.25	5	60.31	56.76
	2.35	0.65	1.43	0.28			
	2.21	0.67	1.31	0.24			
Mean	2.33	0.68	1.41	0.26			
JAERC Model	2.43	0.65	1.61	0.20	5	65.83	62.88
	2.34	0.59	1.53	0.21			
	2.22	0.59	1.47	0.16			
Mean	7	1.835	4.61	0.56			

Where: MBE = total mass before extraction, MAE = Mass of wax and comb aftter extraction, MEH = mass of extracted honey, L = Losses, ET = etraction time, ŋ = etraction efficiency, C = extraction capacity, FARC = Fadis Agricultural Research Center, JAERC = Jimma Agricultural Engineering Research Center

VI. MACHINE CAPACITY

The mean extraction capacities with respective times were found as 68.28, 56.76, and 62.88 kg/hr for the Imported, Fadis Agricultural research Center, and Jimma agricultural engineering research center models, respectively.

All three machines have good capacity when compared to another discovery result, however the imported has better performance than the other two. In line with [2] the capacity of all models was higher than the extraction capacity calculated for the traditional method, which was 6.4 kg/hr, and for the designed hand-driven honey extractor reported as 32.58 kg/hr. The higher capacity of the imported model was due to that gearing mechanism and the cage was framed to keep the falling of the comb during extraction which saved the time of extraction.

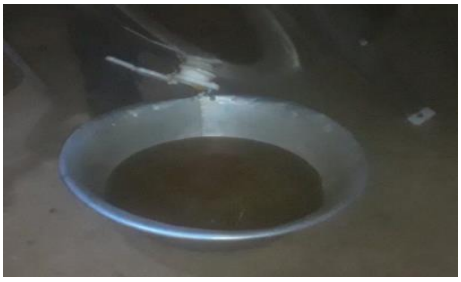

Figure 2: Extracted Honey

Extraction Efficiency

The mean extraction efficiency which indicates the extraction quality of the machines was recorded as 71.39, 65.83, and 60.31 % for the Imported, Jimma Agricultural Engineering Center, and Fadis agricultural research Center models, respectively. The extraction efficiency recorded for evaluating honey extractors was agreed with that of the latest findings [3] had reported an extraction efficiency of 56.30 % for the traditional method and 70.60 % for the hand-driven screw press for honey extraction while [2] reported an extraction efficiency of 72.00 %.

VII. CONCLUSION AND RECOMMENDATION

In short, as observed from the result the gearing mechanism and ergonomic aspects of the honey extractor had affected the extractors by lagging the extraction time. Accordingly, extraction efficiency, extraction capacity, and losses were obtained as Maximum values of 71.39 %, 68.28 kg/hr. and 0.14 % for imported models. Medium values of 65.83 %, 62.88 kg/hr. and 0.26 % recorded for the Jimma Agricultural Engineering Center model. Minimum values of 60.31 %, 56.76 kg/hr. and 0.56 % for the Fadis Agricultural Research Center model respectively. In general, results showed clearly all evaluated machines showed good performance as compared with that of other findings. Therefore, three of them will be recommended for future manufacturing purposes, but for small-scale holders the locally available Jimma Agricultural Engineering Center model honey extractor was recommended based on the price, maintenance availability, simplicity, and durability.

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