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Design and Performance Evaluation of a Juice Extractor Constructed in Nigeria

[1]F.O. Abulude, [2]A.O. Elemide, [1]M.O. Ogunkoya and [1]W.O. Adesanya
[1]Department of General Studies [2]Department of Agricultural Engineering,
Federal College of Agriculture, Akure 340001, Ondo State, Nigeria

Abstract: A manually operated juice extractor was designed, constructed and evaluated 2005 at the Department of Agricultural Engineering, Federal college of Agriculture, Akure, Ondo State Nigeria. In Nigeria, fruit juices are obtained through hand pressing and electrically operated extractors. The hand pressing method is always tedious and time consuming. That of electrically operated is simple but the epileptic power supply is a limiting factor for its use. This manually operated juice extractor was designed and constructed to save time, improve efficiency, increase capacity and reduction in spoilage and waste. Performance evaluation was carried out with the production of orange and pineapple juices. The results showed that the machine produced efficiencies of 83.86 and 85.38% and extraction capacities recorded were 1.29 kg h^{-1} and 1.23 kg h^{-1} for orange and pineapple juices.

Key words: Juice, extraction capacity, efficiency, screw, presser, performance evaluation

INTRODUCTION

Fruit juice extractor is an agricultural technological implement that involves the pressing of some fruit in order to get juice. Fruit juice extraction involves the process of crushing, squeezing and pressing of whole fruit in order to obtain the juice and reduce the bulkiness of the fruit to liquid and pulp. Hand extraction of juice is slow and tedious and also not hygienic enough. The merits of using machine for extraction are time saving, improve efficiency, increase capacity and reduction in spoilage and waste[1-3] the various processes involved in fruit processing Fig. 1 include; sorting washing, pressing, slicing, crushing, extraction, addition of additions, homogenization, pasteurization (heat treatment), packaging and storage[2,4,5].

The early types of mechanical juice extractor include the roller press such as the skinner[6,7]. The roller press is the drum type and handles fruits cut into halves. Nowadays, there are different types of juice extractors they include: Centrifugal, single gear, turn gear, wheat grass and large anger juicers.

Pyke *et al.*[8-10], reported method and equipment of juice extractors suitable for production at an industrial scale. The electrically operated plastic type juice extractors are costly, cannot be used in places where electricity is not available and lack of spare parts. In Nigeria, there is a need to produce a juicer which could beoperated without rigor and used without electricity, therefore the aim of this study was to design, construct and evaluate the performance of a continuous screw presser juice extractor.

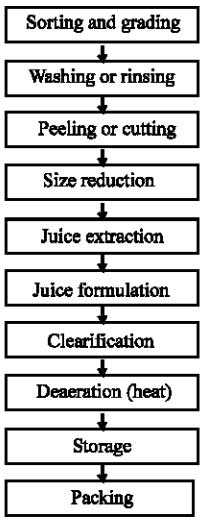


Fig 1: Flow chart of processing of juice

MATERIALS AND METHODS

Material collection: The design, construction and evaluation of the juice extractor were conducted in the Department of Agricultural Engineering, Federal College of Agriculture, Akure, Nigeria in July 2005. The materials Table 1 were purchased at a market shop in Akure.

Corresponding Author: F.O. Abulude, Department of General Studies, Federal College of Agriculture, Akure 340001, Ondo State, Nigeria

Table 1: cost analysis of materials used for the construction of juice extractor

Materials	Division	Quality	Amount(Naira)
Galvanized sheet	12 grade	1	5,000.00
Shaft screw	¾	2	2,500.00
Angle iron	2" X 2"	2	2,000.00
Cutting disk		2	750.00
Electrode	12	1 packet	1,200.00
Faucet	¾	2	600.00
Faucet socket	¾	2	100.00
Bearing		2	1,600.00
Bit	3 mm	7	700.00
Hinges		2	30.00
Brush		2	80.00
Paint		2 cups	700.00
Putty		1	300.00
Workmanship			1,600.00
Bolt and nut	10 mm	6	90.00
Rebit			20.00
Transportation			940.00
1% contingency			1,820.00
Total			20,030.00

- Naira (Nigerian currency)

The cost analysis of the materials in Naira (Nigerian currency) is also shown in Table 2.

Features of design: The juice extractor Plate 1 was constructed with a steel of 2" by 2" mm, a screw shaft of 300 mm diameter was center welded at the center to press the flat plate Fig. 2.1. It has a length of 500 mm. A perforated inner cylinder Fig. 2.2, 240 mm diameter height, 200 mm plate was placed at the bottom. The outer cylinder Fig. 2.3 was 295 mm diameter and height of 250 mm. Other component parts of the juice extractor were socket, hinges, bearing and support metals.

The design was constructed in batch process for easy removal of pulp, seeds and other wastes. The frame Fig. 2.4 which serves as the housing was drilled at the top center for passage of the screw shaft, a bolt of the same size with the screw shaft was welded to the base of the frame for the easy up and down movement of the shaft screw during operation.

The movement of the presser Fig. 2.5 was controlled by a handle joined to the top of the shaft screw for easy revolution of the presser. The faucet Fig. 2.6 attached to the outer cylinder was for easy draining of the juice as it's turned up.

Plate 1: Complete unit of the juice extractor

Experimental run: Oranges and pineapple (5 kg each) were washed, peeled using a knife, poured into the clean machine. The handle of machine was then turned which causes the presser to compress the peeled orange against the perforated cylinders for 15 min. The juice then passed through the perforated holes of the sieve into the collector at the base of the extractor .The presser was then unscrewed to return to its original position and the sieve was taken out to discharge the waste products.

Calculation of parameters

Efficiency of juice

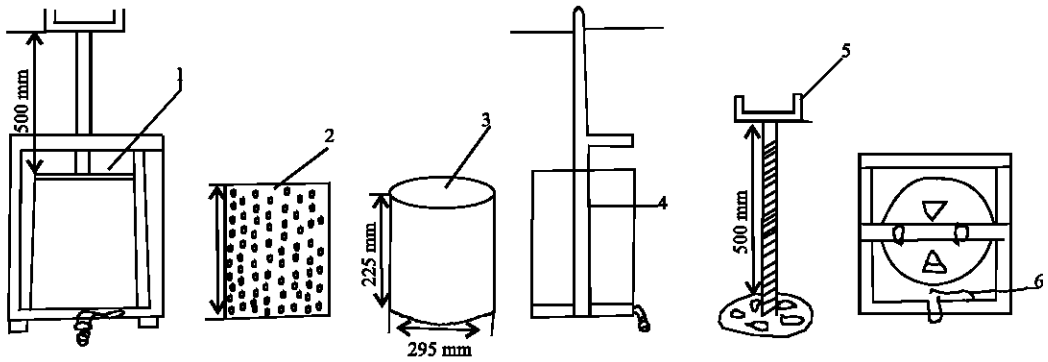
$$\text{Efficiency (\%)} = \frac{\text{Weight of juice extracted}}{\text{Weight of maximum extractable juice}} \text{ X } 100$$

$$\text{Extraction capacity (kg h}^{-1}\text{)} = \frac{\text{Weight of juice extracted}}{\text{Time spent for extraction}}$$

All determinations were in triplicate and values obtained were statistically analyzed using SPSS 10.0 for windows.

Table 2: Performance evaluation of the juice extractor (n=3)

	Orange			Pineapple		
Parameters	Mean	±SD	Cv (%)	Mean	±SD	Cv (%)
Mass of fruit loaded (g)	325.00	35.4	10.9	337.50	17.7	5.2
Mass of fruit extracted (g)	162.50	17.7	10.9	170.30	6.7	4.0
Time taken to extracted juice(min)	9.00	0.0	0.0	29.00	0.0	0.0
Mass of max extracted juice(g)	193.50	12.0	6.2	197.80	6.0	3.1
Juice extraction capacity (kg h^{-1})	1.29	0.1	6.6	1.32	0.1	7.7
Juice extraction efficiency (%)	83.86	3.9	4.7	85.30	2.0	2.3



Serial No.	Components
1	Screw
2	Perforated inner cylinder
3	Outer (receiving) cylinder
4	Frame
5	Presser
6	Faucet

Fig. 2: Diagram of the components of the juice extract

RESULTS AND DISCUSSION

Table 2 depicts the results obtained during performance evaluation. The mean mass of oranges and pineapples loaded were 325 and 337.5 g, respectively. It was observed that more than halve of the fruits weights were obtained for the juices. This could be attributed to the efficiency of the extractor and the time of harvesting (raining season) of the fruits. It is believed that more juice is obtained during the raining seasons than the dry seasons. However, juice contained macerated pulps of fruits and cloudy color. Filtration may be required to remove the tissue particles and care should be taken not to over press the fruits to avoid crushing the seeds. Over ripe and green fruit impair color and flavor[11,12]; this would have significant influence on viscosity and flavor of the processed juice. To produce juice of superior quality that will meet legal requirement, decay fruits should be trimmed while green fruits should be removed before extraction.

The juice extraction capacity of the extractor for pineapple 1.32 kg h^{-1} was higher than that recovered for orange 1.29 kg h^{-1}. There was no significant difference. This was attested for by the low standard deviation and coefficient of variation (%) reported for the two fruits.

CONCLUSION

This study shows that the extractor is effective in the production of orange and pineapple juices and is more effective than using hand and cup to extract juice. The extraction efficiently of machine for orange is 83.86% while that of pineapple is 85.3%. From the same results, it is observed that this machine would solve the problem of producing juices where there is erratic power supply or none at all, since it dose mot involve the use of electricity. However, it is recommended that care should be ensured not to allow grease from the welded parts to come in contract with the juice produced because this would definitely affect the color and taste.

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