Journal of Agricultural Engineering and Technology (JAET), Volume 22 (No.1) March, 2014

PERFORMANCE EVALUATION OF AN IMPROVED NCAM MULTI-FRUIT JUICE EXTRACTOR

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ABSTRACT

A modified fruit juice extractor based on the combination process of mastication through the screw auger and maceration through the tough belt arranged side by side on the shaft was developed. The extractor was tested using orange and pineapple and the quality of the juices produced showed that this multi-fruit extractor is suitable for small, medium and industrial juice processing business in both rural and urban communities.

KEYWORDS: Juice extract, pineapple, orange processing.

1. INTRODUCTION

Fruits juice is originally produced as a result of surplus production of fruits. Fruits are healthful, protective food; contain essential nutrients such as vitamins C, minerals, carotene and dietary fibre. (Dignan et al, 1994). Their availability depends on seasonal, climatic, geographical, environmental and social and economic factors. Fruits are difficult to keep for a considerable length of time, thus ripe fruits are utilized either as fresh or processed into juice and specialty products. Most fruits are perishable in their natural state after harvest; deterioration sets in almost immediately due to metabolic activities which continue even after harvest. (Oyeleke and Olaniyan, 2007). A study carried out on fruits indicated that the losses were up 30% during the rainy season (Tunde-Akintunde and Akintunde, 1996). It is therefore necessary to ensure effective storage and prevent unnecessary losses and wastages by processing fruit into products which will retain the important nutritional value.

Fruit juice extraction involves the process of crushing, squeezing and pressing of whole fruit to obtain the juice and reduce the bulkiness of whole fruit to liquid and pulp. Fruit extraction has been known for quite a long time ever before machines were invented. Extraction started with use of hand that was slow and tedious, the use of machine came into being as the demand for juice consumption increased (Emuleomo, 2005). Juice extraction is the process by which the liquid portion of fruit is separated from the solid portion by means of a juice extractor. Fruit juice extractor is an agricultural technological implement that involves the pressing of some fruits in order to obtain juice (Abulude et al, 2007). The method of juice extraction will differ with the structure and composition of the fruit. Broadly various machines for juice extraction include: Continuous Screw Press, Plunger – Type Press, Roller Type Press, Double Operation, Basket Press, Rack and Cloth Press, Centrifugal Juicers, Hydraulic Press Juicers etc. The early types of mechanical juice extraction included the roller press, such as the skinner (Duckworth 1968, Cruess 1958).The roller press is a drum type device and handles fruits cut into halves. In Nigeria, there are abundant under-exploited juicy fruits with high agro-industrial potentials which can be processed into juices that have plenty of scope for export. Machines used for extraction are imported into the country, because of the cost implication this has hindered the processing of juice by small scale industries. It is therefore essential to develop indigenous equipment for the processing (Adewumi, 1998).To this end, a motorised multi-fruit extractor was modified in NCAM.

The objective of this study was to carry out performance evaluation and determine the physio-chemical properties of juice extracted by NCAM multi-juice extractor.

2. MATERIALS AND METHODS

2.1 Description of the Juice Extractor

The juice extractor constructed in this research work consists of frame made of mild steel, hopper, extracting chamber, pressure plate, juice outlet and chaff outlet and the extracting chamber which consists of the external barrel that will house the sieving screen, the abrasive surface screen and the shaft which is in two form, half part of the shaft is carrying the auger for easy and quick conveyance as well as exerting compressive and shearing forces all made of stainless steel, while the latter part of the shaft is carrying tough belt arranged side by side on the shaft in order to produce soft beat. Extraction takes place by mastication through the auger and maceration through the tough belt.

2.2 Performance Evaluation Test

The machine was tested using pineapple and orange. The fruits were sliced with knife and then weighed before introducing into the hopper. The time of extraction, the weight of the extracted juice and the chaff were noted. As the shaft powered by the electric motor rotates bringing about the compressive and the shear forces. The juice drained out from the perforated screen under the housing and the pulp discharged from outlet. The machine was evaluated using these relationships (Tressler and Joslyn, 1961).

$$J_y = \frac{100W_{JE}}{W_{iJE} + W_{RW}}\% \tag{1}$$

$$J_E = \frac{100W_{JE}}{xW_{FS}}\% \tag{2}$$

$$E_L = \frac{100(W_{FS} - (W_{JE} + W_{RW}))}{W_{FS}} \tag{3}$$

Where $J_{y,}$ J_e and E_L juice yield, extraction efficiency and extraction loss respectively in %; $W_{je,}$ W_{RW} and W_{FS} are weight of juice, extracted residual waste and feed sample respectively. g and x is the juice content of the fruit decimal.

2.3 Physicochemical Analysis

2.3.1 Juice Temperature

The temperature of the juice was measured using a dry bulb thermometer. This was done immediately after extraction process because of the volatile nature of vitamin C content of the juice. (Ishiwu and Oluka, 2004).

2.3.2 Ph Determination

The pH was determined using a universal indicator. A sample of 1ml of the juice was pipetted into a test tube and a drop of the universal indicator was added and swirled vigorously. The corresponding colour on the reading of the indicator was recorded (Ishiwu and Oluka, 2004).

2.3.3 Determination of Iodine Value

The iodine value was determined by weighing 0.25g of fruit juice sample into a stoppered bottle, 12.5ml of dichrolomethane (CH_2Cl_2) and 12.5ml of Wij's solution were transferred into it. 10ml of 10% potassium iodide (10%KI) was also added and the mixture was vigorously shaken and kept in the dark for one hour (1hr) at temperature below 30^0c.

Another flask containing similar but without the fruit juice sample was prepared which served as the blank.The liberated iodine was titrated against 0.02N sodium thiosulphate (0.2N $Na_2S_2O_3$) using 1 ml of starch indicator. It was titrated from blue to colourtless end point. The iodine value was calculated using the formula.

Iodine value

$$= \frac{12.69 \; x \; N \; x \; (B - S)}{Weioght \; of \; sample}$$

Where: 12.69= Constant used to convert molar equivalent thiosulphate to grams of iodine; B= volume of thiosulphate used for blank; S = Volume of thiosulphate used for the sample; N = Normality of the thiosulphate solution (AOAC).

2.3.4 Determination of the Perioxides Value

The perioxides value was determined by properly stirring the juice sample to avoid aeration and 1gram of the juice sample was weighed into a conical flask and dissolved with acetic –chloroform solvent mixture in ratio 3:2 v/v.Then, 1ml of 40% potassium iodide (40%KL) was addede and the mixture was shaken for one minute (1min) before the addition of 75ml of water. The content of the flask was titrated with 0.01N thiosulphate solution using 0.5ml of a freshly prepared 1% starch solution as indicator which was shaken vigorously during titration. At end point (when the blue colour disappeared), the volume of thiosulphate used was noted and recorded as F.

The perioxide value was calculated using the formula:

Peroxide value $= 8000 \; X \; N \; X \; \frac{F}{W}$

Where: 8000 = Constant for expressing the value in µg of oxygen per 100g of juice; N = Normality of the thiosulphate solution; F = Volume of thiosulphate used (ml); W = Weight of the juice sample in grams.

2.3.5 Total Titratable Acidity

A 10ml sample of juice was pipetted and vigorously stirred to remove carbon (iv) oxide. The sample was titrated using 0.1N standardized sodium hydroxide (NAOH) and Phenolphthalein as an indicator. The total titratable acidity (TTA) was calculated as percentage citric acid. The total titratable acidity, TTA in %, was mathematically expressed by Ishiwu and Oluka (2004) as follows:

$$TTA = \frac{V \times 0.0070g \times 100 \times N}{1000 \times Vs} \qquad (9)$$

Where V, N and VS are mole of 0.1N NAOH used, normality and volume of juice sample used, respectively.

2.3.6 Ascorbic Acidic Content

The method of Hartley *et al.,* (1981) was used for the determination of the ascorbic content of the juice. Twenty ml sample of each juice was added to 80ml of distilled water and 10ml of 1M H2SO4. The resulting solution was titrated against 0.05M iodine solution (using 6 drops of starch mucilage as indicator). The vitamin C content was calculated thus:

$$VC100g = \text{titre value} \times F \times 100 \qquad (10)$$

Where titre value and factor are volume of iodine used and concentration (0.00886g) of acid used respectively. Each volume of iodine should be equivalent to 0.00886g of vitamin C.

2.3.7 Total Solids

Total solids were determined by the method used by Osborne and V ought (1979). An empty Petri- dish was washed, oven- dried for 15 min and cooled in a desicator for 20 min. The dried and cooled petri- dish was weighed empty and then reweighed after 10 ml of juice was put into it through a pipette. The petri- dish with its contents was oven- dried at 100℃ for 6h, cooled in the desicator and weighed. The procedure was repeated until a constant weight was obtained. The total solids ST in %, were calculated as follows:

$$ST = \frac{100W2}{W1} \qquad (11)$$

Where, W1 and W2 are weight of fresh juice and weight of dried sample, respectively in g.

3. RESULTS AND DISCUSSION

The juice yield, extraction efficiency and juice loss for orange were 66.67%, 47.52% and 25.78% respectively and for pineapple were 72.5%, 99.7% and 6.77%. This result is in agreement with the work reported by Adewumi, (1999). Fruit juice was also extracted manually as control. Both the machine extracted juice and manually extracted juice were taken to the laboratory in order to determine the effect of machine on the physicochemical properties of the juice and the laboratory result was subjected to statistical analysis, to test for the equality of the means of manual and machine extracted juice from the pineapple and the orange.

Table 1: t-Test for Equality of Means for pineapple.

	V	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% C.I	
ph value	v_1-v_2	34.293	4	.001	.28000	.00816	.25733	.30267
acid value	v_1-v_2	21.213	4	.001	.10000	.00471	.08691	.11309
iodine value	v_1-v_2	.918	4	.411	.02667	.02906	-.05401	.10735
perioxide value	v_1-v_2	-10.607	4	.001	-.05000	.00471	-.06309	-.03691
ascorbic acid	v_1-v_2	-40.305	4	.001	-.19000	.00471	-.20309	-.17691

Where v_1 is machine reading and v_2 is manual reading, V is difference between the two.

From table 1, it was observed that the significant values of the Ph. Value, the acid value, the peroxide value and the ascorbic acid value of pineapple juice extracted were less than 0.05. This indicated that there is no significant difference in the values of the physiochemical parameters of the pineapple juice extracted manually and the juice from the extractor. It is noted that the iodine value is 0.411. This is greater than 0.05 this indicated a large difference between the two treatments and this might be as a result of the difference between the time of extraction which might have given room for fermentation to take place.

Table 2: t-Test for Equality of Means of orange

	V	t	df	Sig. (2-tailed)	Mean Difference	*Std. Error Difference*	95% C.I	
ph value	v_1-v_2	1.225	4	.288	0.01000	*.00816*	-.01267	.03267
acid value	v_1-v_2	42.426	4	.001	0.20000	*.00471*	.18691	.21309
iodine value	v_1-v_2	10.247	4	.001	0.46333	*.04522*	.33779	.58887
peroxide value	v_1-v_2	-112.430	4	.001	-0.53000	*.00471*	-.54309	-.51691
ascorbic acid	v_1-v_2	-4.000	4	.016	-0.01333	*.00333*	-.02259	-.00408

Where: v_1 is machine reading; v_2 is manual reading, V is difference between the two

From Table 2, significant difference of the ph value of the orange juice is greater than 0.05 which shows that there is significant difference between the ph value of orange juice extracted manually and the orange juice from the extractor. This might be as a result of fermentation effect because the extraction process from the machine took place first before the manual process was performed. The time lag is believed to have aided fermentation on the machine extracted orange juice. Meanwhile, the significant difference the acid value, the iodine value, the peroxide value and ascorbic acid value are less than 0.05 showing there is no significant difference. This indicates that these physiochemical properties of orange juice from extractor and the manual were not altered by the method of extraction. Therefore, from the T-test carried out, the values of physiochemical properties showed that the extracted juices were of good qualities.

4. CONCLUSION

This study showed that the extraction of fruit juices through the combination process of mastication through the auger and maceration through the tough belt arranged side by side on the shaft is great improvement on fruit juice extractor. And the quality of the juices produced showed that this multi-fruit extractor is suitable for small, medium and industrial juice processing business in both rural and urban communities.

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