Influence of Moisture Content Variation on the Percentage Oil Yield of Soursop (*Annona muricata*) Seeds.

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Abstract — Soursop (*Annona muricata*) is an exotic fruit grown in the tropics. It is a unique kind of fruit with a green slightly hard skin when unripe that turns yellowish green when ripe. The seeds of Soursop fruit were varied at 4.20%, 8.48%, 12.40%, 15.99% and 19.30% moisture contents (wet basis) and oil was extracted using solvent method. The solvent extraction method was employed using a soxhlet extractor, with normal hexane as the solvent. The soxhlet extractor was set up to run three extraction processes at the same time and the extraction was done in triplicates for each of the moisture contents. The percentage oil yields taking average of the three extracts at the five moisture contents were 23.41%, 33.87%, 30.02%, 33.82% and 23.05% respectively. Therefore it is recommended that to obtain optimum oil yield from soursop seeds, the seeds should be conditioned to 8.48% moisture content, however a range of 8.48% to 15.99% moisture content (wet basis) is suitable for high oil yield from sousop seeds.

Index terms: Moisture Content, Percentage Oil Yield, Solvent Extraction, Soursop seeds, Soxhlet Extractor Variation.

1 INTRODUCTION

Annona muricata is a unique kind of fruit. The skin is green and slightly hard with scattered spines when unripe, while the ripe fruit has a soft yellowish green skin also with soft spines. The edible flesh is hard and white when unripe which turns soft, sticky and creamy as it ripens, with fibrous membranes. *Annona muricata* has quite a number of ovate seeds with a smooth, shiny texture interspaced within the flesh [1].

Soursop (*Annona muricata*) is a broadleaf, flowering, evergreen tree native to Mexico, Cuba, Central America and the Caribbean and northern and South America: Colombia, Brazil, Peru, and Venezuela. Soursop also grows in sub-Saharan African countries that lie within the tropics [2].

Soursop is reported to be adapted to areas of high humidity and relative warm winters, temperatures below 5℃ can damage leaves and small branches and below 3℃ can be fatal to the entire plant [2].

Locally called 'shawa shawa' or 'shawa shop' in some parts of Nigeria, the fruit in its entirety is used in preparing herbal medicine for cancer and diabetes, particularly to indigenous people in regions where it is grown [1], [2]. The pulp has a mixture of sweet and sour taste and is eaten with a spoon, owing to its soft and sticky nature.

1.1 Oil Extraction

Many seeds contain oil, which can be extracted and used in cooking, as a lubricant, biodiesel as well as industrial processes [3].

Oil extraction can be done mechanically with the use of oil press, wooden mortar and pestle and expellers, it can also be done with a solvent though the later is quite a complex process [3].

Janet (2001) reported that principally oil obtained from seed is used as food; eaten raw, baked or used in frying as a medium of heat exchange. They also have a number of none food uses; lubricants, drying base for paints, boiled with alkalis to make soap and as ingredients for cosmetics [3].

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2 MATERIALS AND METHODS

The materials used for this work includes; round bottom flasks, mortar and pestle, spatula, beakers, N-hexane, plastic containers, soxhlet extractor, electric oven, filter paper and digital weighing balance.

2.1 Material Sampling

Soursop fruits harvested from Bwari Local Government Area of Niger state, Nigeria were cut into pieces and the seeds removed from the pulps. The seeds were washed to remove particles of the pulp from them and dried at room temperature. Five samples were randomly selected, containing 50g each to be varied at different moisture contents.

2.2 Moisture Content

The seeds were then oven dried in an air tight oven at a temperature of 105℃ for 6 hours, after which they were allowed to cool and weighed. Continuous weighing was carried out at an interval of 30 minutes, until a steady weight was achieved [4]. The moisture content was afterwards calculated in wet basis using the following equation;

$$M_c = \frac{WW - DW}{WW} \times 100 \quad (1)$$

Where M_c = moisture content (%)

WW =wet weight of sample or the initial weight of sample (g)

DW = dry weight of sample or the final weight of sample (g)

2.3 Moisture Content Variation

The samples were conditioned in order to achieve the different moisture contents, by adding calculated amounts of water to the samples. After the addition of water, they were refrigerated in sealed bags at a temperature of 5℃ for 7 days. This was done to achieve uniformity of water adsorption by the seeds.

Zewdu [5] reported that the amount of water added to vary moisture content can be calculated using equation 2;

$$Q = \frac{W_i(M_f - M_i)}{100 - M_f} \quad (2)$$

Where

Q = amount of water to be added in kg

W_i = initial weight of sample in kg

M_i = initial moisture content of seeds in % and

M_f = final moisture content in %.

The samples were then crushed and

Oil was extracted from the five samples using the soxlet extractor, in the department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna.

2.4 Operation of the Soxhlet Extractor

The soxhlet was set up with the following components; the plastic water tank with a control tap, for regulated flow of water through the condensers so as to ensure that the water condensers are always cool, the liquid condensers to liquefy the hexane vapour back into the extraction chamber containing the sample, round bottom flasks to contain the hexane, a plastic container to collect warm water from the condensers, water hoses connecting the water tank to the condensers and also the condensers to the plastic container.

Three extractors were set up in series, so as to run each of the samples in triplicates. The liquid condensers were interconnected using hoses, to allow water from the tank to flow through them continuously. The sample was crushed into coarse particles. 5g of the crushed sample was completely wrapped in a filter paper to form a thimble and placed at the centre of the extractor. 300ml of n-hexane was put in a round bottom flask and then placed in the thermostat heater set to 40 ^{0}C (just when N-hexane begins to boil). As the solvent boils, the vapour rises through the vertical tube to the condenser, the condensate then drips on the thimble and seeps through the pores of filter paper into the crushed sample. Once the extractor is full, the solvent flows back into the round bottom flask through the siphon tube. The process was allowed to run continuously for 3hours, after which the crushed sample was removed, dried

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in an oven and cooled in a dessicator and then weighed, at 30 minutes interval until a steady weight was observed; an indication of a complete extraction. The liquid in the round bottom flask containing the solvent and the extracted oil was heated in order to recover the n-hexane.

Fig.1 the Soxhlet extractor set up in series for three extraction processes.

The percentage oil content of the seed was then calculated using the weight loss of the sample.

$$Y = \frac{W_i - W_f}{W_i} \times 100 \quad (3)$$

Y = oil yield (%)

W_i = weight of sample before extraction (g)

W_f = weight of sample after extraction (g)

3 RESULTS AND DISCUSSION

3.1 Moisture Content Determination

The initial moisture content of the seeds as calculated from (1) is 4.20%.

In order to check for experimental error in the calculated moisture content, the analysis of variance for the weights of the samples used to calculate the moisture content, which were taken at 1 hour interval until a steady weight was observed during the oven drying process was carried out.

The Analysis of Variance (ANOVA) for the results was computed, using the Completely Randomized Design (CRD).

TABLE 1

Weight of samples taken at 1 hour interval, during oven drying process for moisture content determination.

Treatment	Rep1	Rep1	Rep3	Total	Mean
1	30.110	40.731	41.579	112.42	37.473
2	28.907	39.367	40.347	108.621	36.207
3	28.694	39.045	40.140	107.879	35.96
4	28.670	39.036	40.122	107.828	35.943
5	28.668	39.022	40.112	107.802	35.934
6	28.649	39.012	40.111	107.772	35.924
7	28.647	39.011	40.111	107.769	35.923
Total	202.345	275.224	282.522	760.091	**253.364**
Mean	28.906	39.318	40.360	36.195	**36.195**

The table above shows the weight of the three samples obtained at 1 hour interval during the oven drying process. The interval within which the samples were weighed represents the treatments, while the three different samples represent the replications, used in the analysis of variance.

TABLE 2

Analysis of variance using a completely randomized design (CRD).

Source of Variation	d/f	Sum of Squares	Mean Squares	F CAL	F_T 5%	F_T 1%
Treatment	7	5.907	0.985	0.0025 NS	2.85	4.46
Error	14	561.608	40.115			
Total	21	567.515	28.376			

CV = 17.5%
NS= Not Significant.

The ANOVA table shows a non-significant F-test, an indication that the difference among the treatment is very small. Since the coefficient of variation compares the mean square error, relative to the grand mean, a 17.5% coefficient of variation indicates a high degree of precision in the comparison of the treatments and a relatively good reliability of the experiment.

3.2 Percentage Oil Yield

TABLE 3

Percentage oil yield of soursop seed at varied moisture contents.

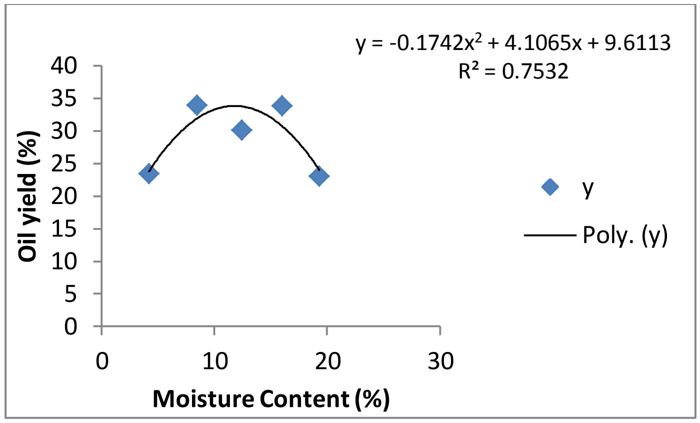
SAMPLES	OIL YIELD %	MOISTURE CONTENT %
1	23.41	4.20
2	33.87	8.48
3	30.02	12.40
4	33.82	15.99
5	23.05	19.30
TOTAL	144.17	60.37
MEAN	28.83	12.07

The above table show that the highest percentage oil yield, that is 33.87% is achievable at 8.48% moisture content (wet basis), this is in line with Kyari's report that the percentage oil yield from seeds is in the range of 26 to 42%, which may be considered as reasonable oil levels [6].

Kyari's report though is a contradiction to Bachmann's report which stated that oil contents of some seeds such as; castor, Almond, Cotton seed, Hemp seed, Linseed, Olive, Peanuts (groundnuts), Perilla seed, Poppy seed, Rape seed (colza), Sesame seed, Sunflower seed and Tung nuts as 50, 50, 30, 35, 40, 40, 50, 50, 50, 40, 50, 35 and 20 percent respectively [3].

The table show high yield values within the range of 8.48% to 15.99% moisture content (wet basis) of the seeds, at 19.30% there is a notable drop in the oil yield. Therefore it is convenient to say high oil yield from Soursop seeds is obtainable between 8.48% to 15.99% moisture content (wet basis).

Linear regression analysis of the oil yield at different moisture contents was done to check for if a linear association exists between moisture content and oil yield of Soursop seeds for the given data.



The above graph of oil yield against moisture content shows the line of best fit for the given data in table 3. The coefficient of determination, r^2 is 75.3%, which is an indication that the oil yield for Soursop seeds can be reliably related to its moisture content by the polynomial equation below

$$y = -0.172x^2 + 4.1065x + 9.6113$$

Where x is the moisture content and y is the oil yield.

4 CONCLUSIONS

In conclusion, Soursop seeds can be said to have good potential for oil production, with the highest oil yield obtainable at 8.48% moisture content (wet basis) of the seeds.

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