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Comparative Study of Melon (Colocynths Ecirrhosus) Depodding Techniques for Effective Post-Harvest Processing

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Abstract

In this study, manual (crude method), mechanical (using the fabricated machine), and traditional depodding techniques were employed in the assessment of melon (Colocynthis Ecirrhosus) post-harvest processing. From the experimental test conducted on fifteen (15) fresh melon pod, an average mass of 0.8588kg and an average diameter of 126.558mm was recorded. At the end of the experiment, an average cutting force of 587.13N was required to break-open a fresh melon pod. Using the crude processing, a mean value of 762.252g was obtained for depodded seeds, 152.569g for undepodded seeds, 55.7465g damaged seeds, and 202.16905g for immature seeds. For mechanical processing, a mean value of 947.008g was obtained for depodded seeds, 56.3409g undepodded seeds, 32.1868g for damaged seeds and 156.603g for immature seeds while the mass of depodded seeds with traditional processing had a mean value of 1159.4435g compared to the mass of immature seeds with a mean value of 184.7556g. On the other hand, the post-harvesting took a mean time of 565.45s to process the melon using the crude method, 118.29s to achieve the tasks mechanically, and 181.2s to achieve the tasks using traditional processing (excluding fermentation period of 6-7 days). While the mechanical process was observed to be expensive with little or no human labor, least processing time and optimum output, the long storage life of seeds, traditional processing was observed to be cheap, intense human labor, extensive processing time including fermentation period, the short storage life of seeds, and better output than the other two processes. However, the crude processing was observed to be cheap, intense human labor, extensive processing time, and the least output of all the processes.

1. Introduction

Melon seeds also known as egusi seeds in Nigeria on average constitute 3.5% of the fruit by weight [1]. The seeds are very nutritious, rich in protein, and are a popular source of food consumed mostly by Africans. It has been referred to in some texts as Citrullus Vulgaris [2] or Colocynths Ecirrhosus [3]. The seeds contain about 53% oil by weight [4] and 32.6% crude protein [5] and also unsaturated fatty acids. Its amino-acid content compares well with those of soybean and whole poultry egg. The melon seed is also a good source of minerals, vitamins, oil, and energy in the form of carbohydrates [6]. The seed contains 0.6 proteins, 4.6g carbohydrates, 33 mg vitamin C, 0.6 g crude fiber, 230 mg K, 16 mg P, 17 g Ca per 100 g edible seeds, and unsaturated fatty acids [7]. In Nigeria, farmers still employ the traditional methods of melon depodding which may involve: breaking open the fruits with a knife, burying the fruits to decompose underground, and cracking the shells to remove the seeds. Improper methods of depodding melon can cause problems during the separation of seeds from the pulp or during germination of the seed [8]. Processing of melon into eatable food is very cumbersome as it involves shelling, washing, coring, drying, fermentation, drying, and oil extraction. Shelling involves removing the outermost part (husk) from the melon kernel. Here, the seed is separated from the spiny husk [9]. Several studies in the past have attempted mechanizing the melon depodding machine.

Oloko and Agbetoye [10] developed a melon depodding machine with a spike-screw conveyor. The machine had depodding efficiency that varied from 31.9% to 62.1% while the overall efficiency varied between 13.1% and 68.8%. Osunde and Vandi [11] designed and developed egusi seed extractor in order to improve the number of undamaged melon seeds recovered from the extraction process. The melon seed extractor was designed to remove seeds from the melon fruit while separating them from the pulp by water pressure approach. The machine had the same working principles as that of Oloko and Agbetoye [10], with an innovation of a water pressure sprayer system in-cooperated into the machine. Nwakuba [12] designed a melon depodding machine where fermented melon pods are fed into the machine through the hopper. The blade was designed with a rotating shaft with protruding spikes around the surface. The spikes were meant to impact and break the pods, releasing the melon seeds which are separated from the pod and are subsequently collected at the outlets. Ogiemudia et al. [13] designed, fabricated, and tested a melon depodding machine for use in the Nigerian agricultural sector. The average mass of melon pod of 1.671 kg and the average diameter of the melon pod of 139.25 mm were obtained experimentally. From the performance test carried out on the machine, average percentage of depodded seeds of 91.1255%, average percentage of undepodded seeds of 7.2915%, the average percentage of damaged seeds of 1.5835% and the average percentage of useful seeds of 98.4165%. Using an impeller speed between 1400 and 1800 rpm at a moisture content of 16.47% ±2. Oriaku et al. (2013) [14] obtained a percentage of breakage between 40 and 80%. However, with an optimum speed of 1000 rpm, the breakage percentage reduced to 12% for the impact approach and 1% for the attrition approach. In Nigeria, farmers still employ the traditional methods of melon depodding which may involve: breaking open the fruits with a knife, burying the fruits to decompose underground, and cracking the shells to remove the seeds. Improper methods of depodding melon can cause problems during the separation of seeds from the pulp or during germination of the seed [8]. Comparative study of melon (Colocynthis Ecirrhosus) depodding techniques was carried out in this paper for effective post-harvest processing of melon pods.

2. Methodology

Three processes of melon depodding were employed in this study as follows: manual (crude method) process of fresh melon pod, mechanical (using the fabricated machine) process of the fresh melon pod, and traditional process (fermented melon pods). Samples of the fresh melon pod were depodded manually with mortar and pestle, the mass of the melon pod was recorded as M, the mass of pulp removed was recorded as, the mass of seed depodded was recorded as, the mass of undepodded seed depodded was recorded as, the mass of the damaged seed was recorded as, while the mass of immature seed when depodded was recorded as, the time taken for depodding was recorded as seconds (s).

i. Mass of Pod (M): This is the mass of the melon pod as recorded by the weighing balance and it was measured in kg.

ii. Mass of Pulp (M_1): The mass of the melon pod is usually made up of the mass of pulp and the mass of the seeds. The pulp is the part in which the seed is embedded into, it carry the major mass of the pod and it has the ability to float when submerge in a fluid. This is usually the bitter part of the egusi melon and has not really found any significant use. The mass of the pulp was measured on a weighing balance in (kg) after the pod have been depodded both manually and the use of the fabricated machine and recorded as M_1.

iii. Mass of depodded seeds (M_2): This is the mass of mature seeds successfully depodded from the pod and it was measure using an electronic scale in (g).

iv. Mass of undepodded seeds (M_3): Undepodded seeds are the seeds embedded in the pulp after depodding. The mass of the undepodded seeds was measured using an electronic scale in (g).

v. Mass of damaged seeds (M_4): Damaged seeds are the seeds that were deformed during the depodding process. The mass of damaged seeds were measured using an electronic scale in (g).

vi. Mass of immature seeds (M_5): One of the observations of egusi melon pod was the presence of immature seeds. The immature seeds were observed to be the seeds that were not fully matured; some of this seed either have partial seed in them or none at all. The immature seeds were measured using an electronic scale in (g).

vii. Time Taken (s): This was the total time spent during the depodding process and was recorded in seconds (s).

Equipment employed in the measuring process to determine the mass of melon pod, mass of pulp and the mass of depodded seeds are shown in Figure 1a-c.

a. Mass of pod **b. Mass of pulp** **c. Mass of depodded seeds**

Figure 1. Equipment and the measuring process of melon

2.1. Experimental Determination of Cutting force

In other to calculate the power required, torque, and size of electric motor to be used for manufacturing the melon depodding machine, experiment were carried out in other to determine the cutting force required to crush the melon pod. The experimental set-up and cutting process of the melon pod are show in Figure 2a and 2b. This test was usually preceded by weighing of the cubes to determine their densities. After determining the mass and diameter of each pod, it was placed on the steel plate beneath the upper section of the machine which has a cutting tool positioned immediately above the specimen. Compressive stress/load was then applied at a constant rate of 4.5-9.0kN/sec until the cutting tool cuts through the pod. The cutting force was recorded according to the gauge reading. The minimum, maximum and average cutting forces were determined from the experiment and results obtained are presented in the results section. Fifteen (15), melon pod were selected at random and used for this experiment.

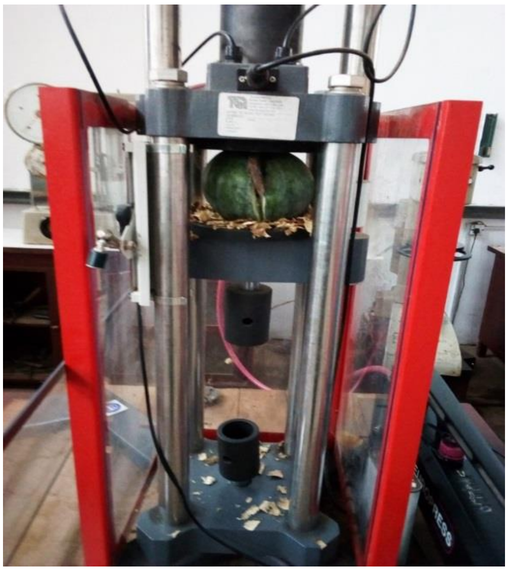


Figure 2a. Melon Pod during cutting test

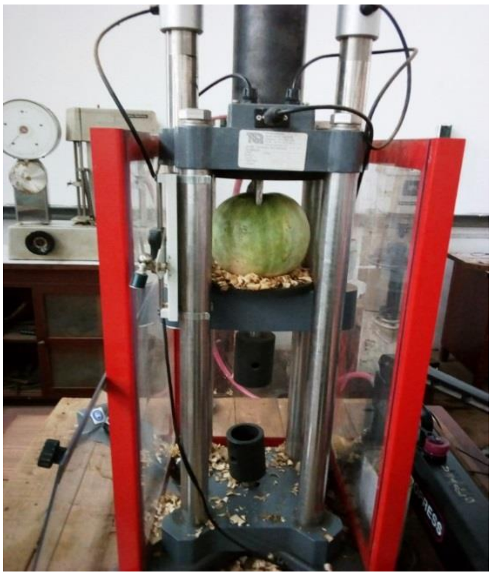


Figure 2b. Experimental set-up

2.2. Manual (Crude Method) Processing

From the preliminary experiments, it was observed that fresh melon fruit can be depodded manually using any forms of mechanical operation capable of breaking the pod. In this study, mortar and pestle was used to manually break-open the fresh melon fruit. Mortar and pestle is a Nigerian made ancient tool used to crush materials from their solid state to a molten state. The principles involve washing the melon pod, mortar and pestle to avoid sand and using pestle to crush pods inside the mortar. This is followed by extraction and weighing of the seeds to determine the effectiveness of the method employed which is a function of the time spent, quantity of damaged and undamaged seeds.

2.3. Description on Traditional Depodding Techniques

Unlike the manual depodding of fresh melon fruit, the traditional depodding of melon involves fermentation of the pod. The flow diagram in Figure 3 illustrates the process for fermentation process (traditional depodding techniques) of melon.

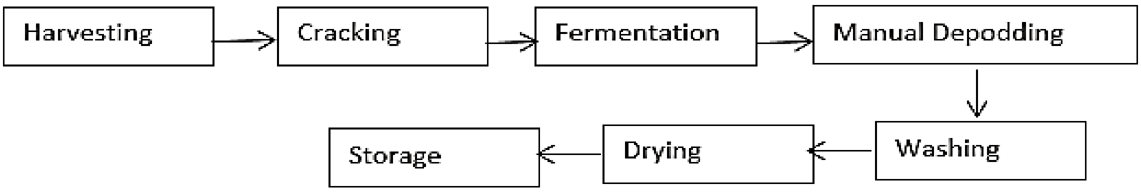
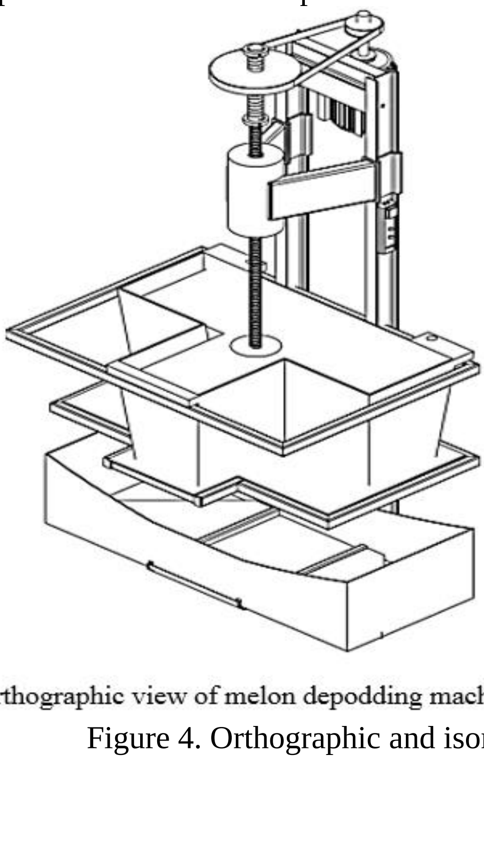


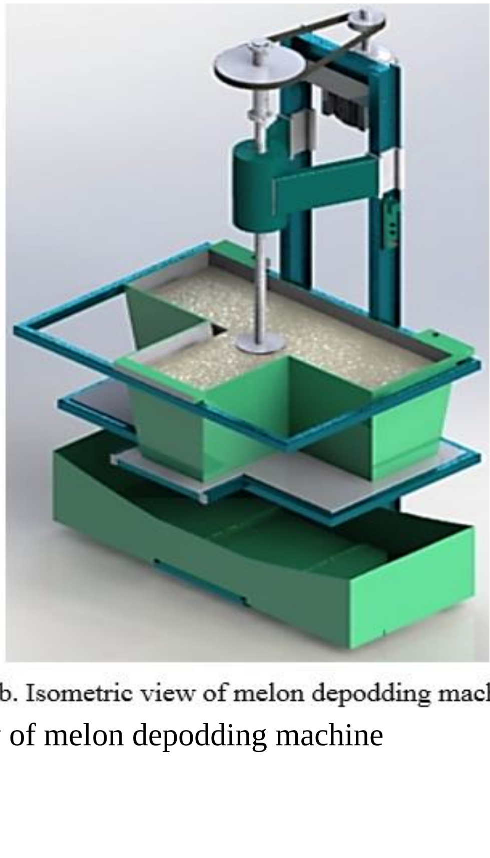
Figure 3. Flow diagram of fermentation melon depodding techniques

2.4. Description and Modelling of Melon Depodding Machine

The main component of the machine are frame, hopper, screw shaft, blade holder, base bracket, blade, stationary knife, control switch, driven pulley, electric motor, driver pulley, belt, separation chamber, and the stopper. The working mechanism involves the conversion of rotatory motion of the screw shaft into the translational motion of the jaw, which in turn causes the motion of the jaw to cut the melon pod against the lower jaw through a screw mechanism. A control mechanism is attached to the stopper which triggers the control switch and also causes the reverse motion of the machine. The crude mixture of the melon pod is released into the separation chamber containing water. The pulps were collected at the top of the chamber while the seed was collected at the base of the chamber. Prior to fabricating the melon depodding machine, SOLIDWORKS software, 2018 version was employed in designing and representing the orthographic and isometric views of the machine presented in Figure 4, as well as the labelled exploded view shown in Figure 5. SOLIDWORKS is a solid modelling Computer Aided Design (CAD) as well as Computer Aided Engineering (CAE) tool that runs mainly on Microsoft Windows. Modelling procedure of the melon depodding machine commenced with 2D sketch, consisting of geometries such as arcs, points, conics, lines, splines and so on. Dimensions were added to the sketch to define the size and configuration of the geometry. Relations in the tool bar were used to define features such as parallelism, tangency, concentricity, perpendicularity among others. In the part assembly, sketches of individual parts were assembled together to form the intended solid model of the machine. Views were automatically generated from the solid model; and dimensions and tolerances were added to the drawing as required. SOLIDWORKS software have been successfully employed in modelling of reciprocating piston [15], remotely controlled hydraulic Bottle Jack [16], vehicle compression springs [17], two stroke internal combustion engine [18], High Density Polyethylene Liner HDPL [19], conceptual framework for biothermal variations in municipal solid waste landfill [20] etc. Design drawings of the melon depodding machine were carried out to determine the specific dimension to be adopted for the fabrication process.



a. orthographic view of melon depodding machine



b. Isometric view of melon depodding machine

Figure 4. Orthographic and isometric view of melon depodding machine

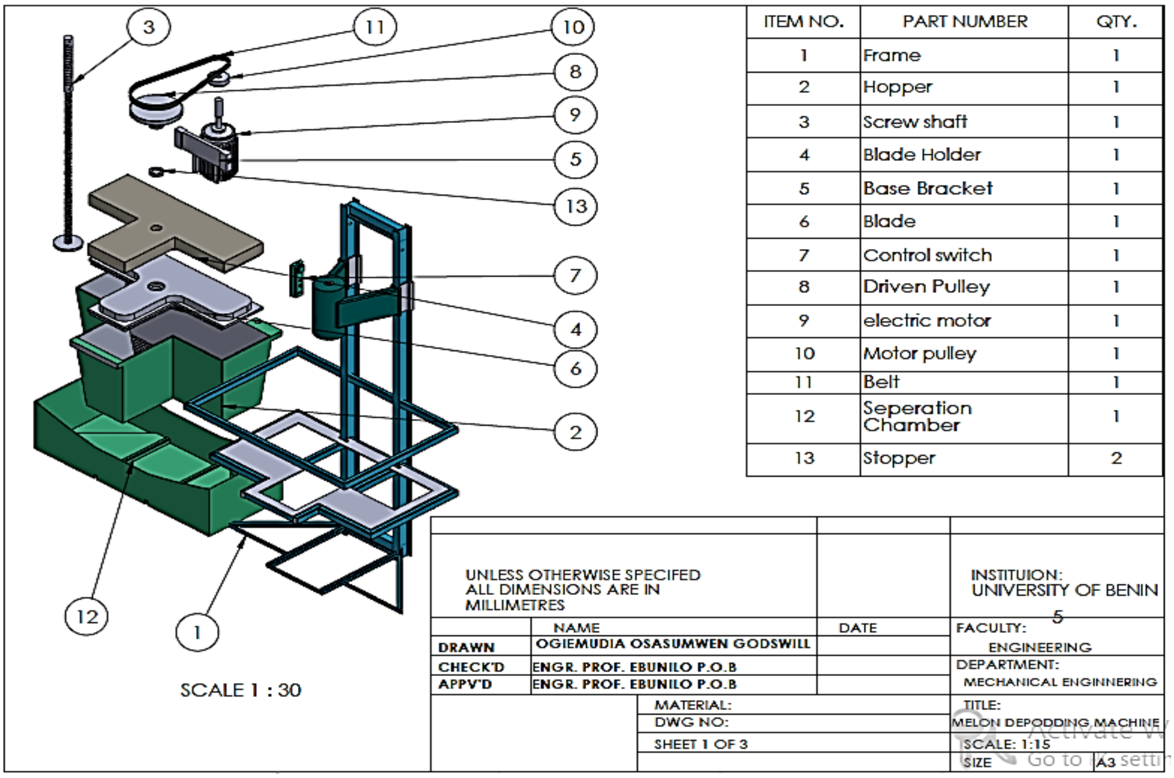


Figure 5. Exploded view of labelled melon depodding machine

To design for the power required to operate the machine, Equation 5 can be employed [21].

$$Power = Force * Velocity \quad (1)$$

Recall that,

$$v = \frac{2\pi N}{60} \quad (2)$$

where N is the rotational speed of the driver sprocket

Substituting Equation (1) into Equation (2),

$$P = \frac{2\pi NF}{60} \quad (3)$$

$$P = \frac{2 \ x \ 3.142 \ x \ 48 \ x \ 222.2}{60} = 1117 \ watts$$

But; 746watts = 1horse power (1hp)

This implies that; 1117watts = 1.5hp

Taking a service factor of 1.5

$$1.5 * 1.5hp = 2.25hp$$

Therefore, 2.5hp electric motor is required.

To design for the speed reducer unit, Equation 4 was employed [22].

$$\frac{D_1}{D_2} = \frac{N_2}{N_1} \quad (4)$$

were electric motor speed (N_1) is 1440rpm, driver sprocket diameter (D_1) is100mm, driven sprocket diameter (D_2) is 50mm and N_2 is the rotational speed of the driver sprocket unknown.

$$N_2 = \frac{N_1 \times D_1}{D_2} \quad (5)$$

$N_2 = \frac{1440 \times 100}{50} = 2880rpm$

Using a speed reduction gear box of 60:1

$N_2 = \frac{2880}{60} = 48rpm$

The center to center distance between the driver and driven sprocket is given by Equation 6

$$C = 2D_1 + D_2 \quad (6)$$

where D_1 is the diameter of the driver sprocket = 100mm = 0.1m, D_2 is the diameter of the driven sprocket = 50mm = 0.05m, C is the center distance between driver and driven sprocket. Therefore:

$C = 2 \times (0.1 + 0.05) = 0.3m$

3. Results and Discussion

Table 1 represent the experimental results to determine the cutting force of the melon pods. Although the pods were selected randomly from a farm in Ikpoba Okha Local Government Area in Benin City, the results were presented with increasing order in the mass of pods. It can be observed that the diameter of each melon pod increased concurrently with the mass of pod. Moreover, the cutting force increased with increasing mass and diameter of each melon pod subjected to the experiment. From the experimental test carried out on fifteen (15) fresh melon pod, an average mass of 0.8588Kg and an average diameter of 126.558mm was recorded. The fresh melon pod was prepared for experiment and test was carried out to determine the cutting force required to cause failure using the universal testing machine in the mechanical lab of the University of Benin, Benin City. An average cutting force of 587.13N was obtained. Hence, to design a machine capable of cutting through melon pods during post-harvest processing, an average of 587.13N is required.

Table 1. Experimental result of the cutting force of melon pod

S/N	Mass of Pod (kg)	Diameter of Pod (mm)	Cutting Force (N)
1	0.421	103.67	500
2	0.548	113.1	420
3	0.565	109.96	800
4	0.596	113.1	300
5	0.713	116.24	400
6	0.754	128.81	700
7	0.83	125	407
8	0.88	125	600
9	0.923	131	500
10	0.966	132	580
11	1.01	131	550
12	1.06	135	500
13	1.09	135	650
14	1.209	144.5	800
15	1.317	155	1100
Mean	0.8588	126.558	587.13

After crushing the melon pod, four categories of seeds were manually collected and measured using digital weighing balance. These four categories of seeds which are found inside a melon pod once opened irrespective of the method are as follows:

i. Depodded seeds: These were matured seeds that were successfully extracted from the melon pod when subjected to mechanical action.
ii. Undepodded seeds: These were matured seeds that were left inside the pulp at the end of the depodding process. These left-over seeds were removed manually and measured using a digital weighing balance.
iii. Damage seeds: These were matured seeds that was damaged/deformed as a result of the mechanical process of depodding. These seeds were manually sorted and measured using a digital weighing balance.
iv. Immature seeds: These were seeds that were not fully matured at the time of harvesting.

Table 2 represent results of post-harvest processing of melon using crude method. From the results, it can be observed that the mass of depodded seeds from the experiments is much with a mean value of 762.252g compared to the mass of undepodded seeds and the mass of damaged seeds with mean values of 152.569g and 55.7465g. On the other hand, the mass of immature seeds with mean value of 202.16905g is observed to be more than the mass of undepodded seeds and damaged seeds but lesser than the mass of depodded seeds by 560g. As shown in Table 2, the post-harvest processing time for each melon pod using manual method increased as the mass and diameter of pod also increased. Similar trend of increase was also observed in the mass of pulp, mass of depodded seeds, undepodded seeds, damaged seeds and immature seeds as the mass and diameter of melon pod increased.

Table 2. Post-harvest processing of melon using crude method

S/N	Mass of Pod (kg)	Average Diameter of Pod (mm)	Mass of pulp (Manual, kg)	Mass of depodded seeds (Manual, g)	Mass of undepodded seeds (Manual, g)	Mass of damaged melon seeds (Manual, g)	Mass of immature seeds (Manual, g)	Time Taken (Manual, s)
1	1.53	148	1.383	70.469	22	5	29.219	90
2	2.69	144	2.458	112.219	51.6	7	41.319	110
3	3.67	136.67	3.284	259.54	43.408	11	52.497	150
4	4.49	111	4.018	307.524	62.542	14	67.759	200
5	5.73	129.4	5.161	375.403	63.932	19	90.23	280
6	7.26	124	6.599	413.932	86.139	25	115.888	360
7	8.61	134.429	7.843	505.411	80.245	27	134.408	400
8	9.96	125.75	9.065	581.041	105.564	41	147.015	450
9	11.19	138.22	10.187	633.901	135.75	48.25	165.505	470
10	12.72	145	11.612	705.201	140.909	55.5	186.077	550
11	13.84	133.45	12.331	813.161	107.549	60.4	207.843	589
12	15.11	140.33	13.789	921.42	94.294	60.15	224.949	590
13	16.91	145.38	15.452	1023.13	93.979	69.55	251.24	700
14	18.91	150.71	17.267	1086.84	172.445	76.2	287.39	760
15	20.73	155.33	18.963	1171.76	180.227	96	299.293	800
16	22.35	159.37	20.487	1146.86	290.766	100	304.959	860
17	23.69	157.65	21.744	1157.37	345.819	95	328.296	900
18	25.22	154.67	23.169	1260.15	318.933	101	350.925	980
19	25.82	148.42	23.702	1301.15	324.539	98.8	373.876	1000
20	27.57	150.8	25.331	1398.56	330.736	105.08	384.693	1070
Sum	277.7	2832.58	253.845	15245	3051.38	1114.93	4043.381	11309
Mean	13.88	141.629	12.6923	762.252	152.569	55.7465	202.16905	565.45

Table 3 represent results of post-harvest processing of melon using mechanical method. From the results, it can be observed that the mass of depodded seeds from the experiments is much with a mean value of 947.008g compared to the mass of undepodded seeds and the mass of damaged seeds with mean values of 56.3409g and 32.1868g. On the other hand, the mass of immature seeds with mean value of 156.603g is observed to be more than the mass of undepodded seeds and damaged seeds but lesser than the mass of depodded seeds by 790.405g. As shown in Table 3, the post-harvest processing time for each melon pod using mechanical method increased as the mass and diameter of pod also increased. Similar trend of increase was also observed in the mass of pulp, mass of depodded seeds, undepodded seeds, damaged seeds and immature seeds as the mass and diameter of melon pod increased.

Table 3. Post-harvest processing of melon using mechanical method

S/N	Mass of Pod (Mechanical, kg)	Average Diameter of Pod (Mechanical, mm)	Mass of pulp (Mechanical, kg)	Mass of depodded seed (Mechanical, g)	Mass of undepodded seed (Mechanical, g)	Mass of damaged seed (Mechanical, g)	Mass of immature seed (Mechanical, g)	Time Taken (Mechanical, s)
1	1.53	138	1.3	100.469	28.904	8	34.596	20
2	2.69	144	2.13	168.709	12.334	4.89	49.688	26
3	3.67	136.67	3.27	327.27	18.378	24.322	59.42	35
4	4.49	111	4.01	388.344	36.648	18.278	71.292	48
5	5.73	129.4	5.19	472.813	40.554	33.478	81.428	64
6	7.26	124	6.66	520.092	30.001	20.021	82.124	76
7	8.61	134.429	7.91	604.561	17.443	18.905	87.468	85
8	9.96	125.75	9.28	700.561	42.75	13.956	110.472	92
9	11.19	138.22	10.206	790.561	54.751	20.91	128.808	102
10	12.72	145	11.632	870.561	62.731	24.451	120.304	113.9
11	13.84	133.45	12.292	948.561	45.729	27.851	98.776	117.9
12	15.11	140.33	13.779	1032.96	41.452	17.246	92.548	129
13	16.91	145.38	15.567	1142.96	58.629	25.851	130.38	146
14	18.91	150.71	17.176	1292.96	68.635	33.674	174.489	156
15	20.73	155.33	19.054	1401.86	73.462	49.876	230.841	166
16	22.35	159.37	20.195	1493.86	81.745	56.234	297.796	176
17	23.69	157.65	21.726	1554.86	96.731	51.671	310.668	188
18	25.22	154.67	23.176	1639.33	89.784	60.247	306.944	198
19	25.82	148.42	23.757	1689.33	104.912	63.641	315.66	207
20	27.57	150.8	25.234	1799.53	121.245	70.234	348.35	220
Sum	277.7	2822.58	253.844	18940.2	1126.82	643.736	3132.05	2365.8
Mean	13.885	141.129	12.6922	947.008	56.3409	32.1868	156.603	118.29

The traditional method (fermentation) of depodding melon pods in this study took about 6-7 days before the melon fruit fermented and was ready for scooping and washing. The advantage of this process is that there is no damage seeds after washing the seeds. However, the disadvantage is that microorganism which causes fermentation of the melon pods infest on the seeds if the fermentations process prolongs without scooping and washing. Another demerit of the technique is the stress and timeframe required for the processing. Table 4 represent results of post-harvest processing of melon using fermentation method. From the results, it can be observed that the mass of depodded seeds from the experiment is much with a mean value of 1159.4435g compared to the mass of immature seeds with a mean value of 184.7556g. As shown in Table 4, the post-harvest processing time for the melon pods using fermentation method increased as the mass and diameter of pod also increased. Similar trend of increase was also observed in the mass of depodded and immature seeds as the mass and diameter of melon pod increased.

Table 4. Post-harvest processing of melon using traditional (fermentation) method

S/N	Mass of Pod (kg)	Average Diameter of Pod (mm)	Mass of Depodded Seeds (Fermentation process, g)	Mass of Immature Seeds (Fermentation process, g)	Time Taken (Fermentation process, s)
1	1.53	140	130.05	30	15
2	2.69	144	220.58	56.49	40
3	3.67	136.67	275.25	67.73	60
4	4.49	111	354.71	80.82	75
5	5.73	129.4	458.4	97.41	95
6	7.26	124	624.36	106.16	110
7	8.61	134.429	766.29	99.15	127
8	9.96	125.75	846.6	119.52	139
9	11.19	138.22	917.58	156.66	155
10	12.72	145	1068.48	165.36	170
11	13.84	133.45	1164.44	135.4	200
12	15.11	140.33	1329.68	111.54	219
13	16.91	145.38	1369.71	119.83	225
14	18.91	150.71	1645.17	206.119	232
15	20.73	155.33	1803.51	230.103	239
16	22.35	159.37	1788	347	245
17	23.69	157.65	1871.51	397.49	263
18	25.22	154.67	2068.04	379.18	300
19	25.82	148.42	2143.06	388.18	315
20	27.57	150.8	2343.45	400.97	400
Mean	13.885	141.62895	1159.4435	184.7556	181.2

3.1. Percentage of Extractable Seeds

In order to calculate the performance efficiency of depodding melon, it was necessary to determine the ratio or the percentage of extractable seeds per given mass of melon pods. The percentage of seed extracted was calculated using the relation in Equation 7a-b.

$$Percentage\ of\ seed\ extractable = \frac{Mass\ of\ depodded\ seed}{Mass\ of\ pod} * 100\% \quad (7a)$$

$$\frac{M_2 + M_4 + M_5}{M_2 + M_3 + M_4 + M_5} * 100\% \quad (7b)$$

The percentage of seeds extracted using manual, mechanical and fermentation process are presented in Table 5. The result indicates that using manual processing method, the percentage of seeds extracted from each pod varied throughout the 20 melon pods that were experimented, and that resulted in mean value of 86.99%. Similar trend was observed in the case of melon seeds extracted using mechanical process, but the mean value (94.65%) was observed to be higher than that obtained from the manual processing method. However, there was no variation in the percentage of all the seeds extracted from each melon pod using fermentation process, and a mean value of 100% was obtained from the process. This therefore implies that each processing method has its own advantage and disadvantage. For example, manual method was observed to produce broken seeds that were more than that of the mechanical process, mechanical process was observed to be the most expensive of all the processes while fermentation process was observed to produce no broken seeds but required time for processing, of which the fermentation period also caused severe environmental pollution.

Table 5. Percentage of seeds extracted using manual, mechanical and fermentation process

S/N	Mass of pod (kg)	Percentage of Extractable seeds (fresh pod, manual process, %)	Percentage of Extractable seeds (fresh pod, mechanical process, %)	Percentage of Extractable seeds (fermentation process, %)
1	1.53	82.63	83.19	100
2	2.69	75.68	94.77	100
3	3.67	88.15	95.72	100
4	4.49	86.16	92.88	100
5	5.73	88.35	93.55	100
6	7.26	86.56	95.4	100
7	8.61	89.26	97.61	100
8	9.96	87.93	95.07	100
9	11.19	86.2	94.5	100
10	12.72	87.05	94.18	100
11	13.84	90.95	95.92	100
12	15.11	92.75	96.5	100
13	16.91	93.46	95.68	100
14	18.91	89.37	95.63	100
15	20.73	89.69	95.82	100
16	22.35	84.22	95.76	100
17	23.69	82.05	95.2	100
18	25.22	84.3	95.72	100
19	25.82	84.53	95.17	100
20	27.57	85.1	94.82	100
Mean	13.885	86.99	94.65	100

3.2. Percentage of Useful Seeds

This is calculated using the relation;

$$percentage\ of\ useful\ Seeds = \frac{Mass\ of\ useful\ seeds}{Total\ mass\ of\ seeds} * 100\% \quad (8a)$$

$$= \frac{M_2}{M_2 + M_3 + M_4 + M_5} * 100\% \quad (8b)$$

The percentage of useful seeds extracted with manual, mechanical and fermentation process are presented in Table 6. The result indicates a mean value of 64.8795% for useful seeds extracted with manual, a mean value of 78.317% for useful seeds extracted with mechanical process and a mean value of 85.542% for useful seeds extracted with fermentation process. From the mean results, the percentage of useful seeds extracted with fermentation process is obviously the highest, making it the most effective but the advantages and disadvantages as previously stated plays a vital role in the selection of melon processing method.

Table 6. Percentage of useful seeds extracted with manual, mechanical and fermentation process

S/N	Mass of Pod (kg)	Percentage of useful Seeds (fresh pod, manual process, %)	Percentage of useful Seeds (fresh pod, machine process, %)	Percentage of useful Seeds (fermented pod, fermentation process, %)
1	1.53	55.62	58.42	81.26
2	2.69	52.9	71.6	79.61
3	3.67	70.83	76.22	80.25
4	4.49	68.06	75.47	81.44
5	5.73	68.43	75.26	82.47
6	7.26	64.58	79.74	85.47
7	8.61	67.65	83	88.54
8	9.96	66.43	80.73	87.63
9	11.19	64.46	79.45	85.42
10	12.72	64.83	80.75	86.6
11	13.84	68.39	84.62	89.58
12	15.11	70.83	87.23	92.26
13	16.91	71.15	84.18	91.96
14	18.91	66.97	82.37	88.87
15	20.73	67.06	79.83	88.69
16	22.35	62.24	77.42	83.75
17	23.69	60.08	77.21	82.48
18	25.22	62.05	78.2	84.51
19	25.82	62.01	77.72	84.66
20	27.57	63.02	76.92	85.39
Mean	13.885	64.8795	78.317	85.542

3.3. Percentage of Non-Useful Seeds

The seed loss during depodding can be calculated using the following relation:

$$Non\ Useful\ Seeds = \frac{Mass\ of\ undepodded\ seeds + mass\ of\ damaged\ seeds}{Total\ mass\ of\ seeds} \qquad (9a)$$

$$= \frac{M_3 + M_4}{M_2 + M_3 + M_4 + M_5} * 100\% \qquad (9b)$$

The percentage of non-useful seeds extracted with manual, mechanical and fermentation process are presented in Table 7. The result indicates a mean value of 21.839% for non-useful seeds extracted with manual, a mean value of 16.337% for non-useful seeds extracted with mechanical process and a mean value of 14.458% for non-useful seeds extracted with fermentation process. From the mean results, percentage of non-useful seeds extracted with fermentation process is obviously the least, indicating that fermentation process despite its disadvantages is one of the cheap processes that minimize losses in terms of melon seeds, followed by mechanical process.

Table 7. Percentage of non-useful seeds extracted with manual, mechanical and fermentation process

S/N	Mass of Pod (kg)	Percentage of non-useful Seeds (fresh pod, manual process, %)	Percentage of non-useful Seeds (fresh pod, machine process, %)	Percentage of useful Seeds (fermented pod, manual process, %)
1	1.53	27.01	24.77	18.74
2	2.69	22.78	23.16	20.39
3	3.67	17.33	19.5	19.75
4	4.49	18.1	17.41	18.56
5	5.73	19.91	18.29	17.53
6	7.26	21.98	15.66	14.53
7	8.61	21.61	14.6	11.46
8	9.96	21.5	14.34	12.37
9	11.19	21.74	15.05	14.58
10	12.72	22.21	13.43	13.4
11	13.84	22.56	11.3	10.42
12	15.11	21.92	9.27	7.74
13	16.91	22.31	11.51	8.04
14	18.91	22.4	13.26	11.13
15	20.73	22.62	15.99	11.31
16	22.35	21.98	18.35	16.25
17	23.69	21.97	17.99	17.52
18	25.22	22.25	17.52	15.49
19	25.82	22.53	17.45	15.34
20	27.57	22.07	17.89	14.61
Mean	13.885	21.839	16.337	14.458

4. Conclusion

In this study, three (3) methods (crude, mechanical, and traditional) of melon (Colocynthis Ecirrhosus) depodding techniques were compared to determine the effectiveness of each method for post-harvest processing. The results revealed that adopting a mechanical approach in the post-harvest processing of melon pods required the least processing time, followed by the fermentation process excluding the fermentation period and the manual process. On the other hand, it was observed that traditional processing yielded the highest amount of depodded seeds, followed by mechanical processing before manual processing. In general, fermentation process yielded the highest percentage of extracted seeds from twenty (20) melon pods that were experimented, with a mean value of 100%, followed by the mechanical process with a mean value of 94.65% before the manual process which was the least with a mean value of 86.99%. Similarly for the percentage of useful seed, the fermentation process yielded a mean value of 85.54%, followed by a mechanical process with a mean value of 78.31% before the manual process which was also the least with a mean value of 64.87%. For the percentage of non-useful seeds, the fermentation process yielded the least percentage of useful seeds with a mean value of 14.458%, followed by a mechanical process with a mean value of 16.33% before the manual process which was the highest with a mean value of 21.83%. This lead to the conclusion that the mechanical processing technique of melon depodding is more ideal for large-scale/industrial as well as commercial purposes where a large number of melon pods are processed while fermentation process is ideal for small scale/domestic use. This conclusion is based on the fact that mechanical technique during post-harvest processing of melon is not labour-intensive compared to the other two (2) processes evaluated in this study.

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