DEVELOPMENT AND PERFORMANCE EVALUATION OF A MELON WASHING MACHINE FOR SHORT PERIOD FERMENTED MELON MATERIALS

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ABSTRACT

A melon seed washing machine was designed and fabricated for washing short period fermented melon materials obtained from depodded fresh melon pods. The developed melon seed washing machine has four components; the washing basket, impeller disk, impeller shaft and electric motor. The developed melon seed washing machine was evaluated at fermentation and washing stages. During evaluation three operational factors were varied, screen size (S) at four levels (15, 20, 25 and 30 mm), fermentation period (F) at three levels (2, 4 and 6 days) and bag type (B) at three levels (jute, black and white polyethylene bags). The statistical design was 4x3x3x3 factorial experimental design replicated thrice and 108 experimental runs were made during evaluation of melon washing machine. Statistical software SPSS 18 was used to carry out statistical analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) on the evaluation data of the melon washing machine. The statistical results of the (ANOVA) and (DNMRT) of the melon washing machine showed that only the fermentation period and its interactions with bag type has significant effect on the washing performance index (WPI) of the machine at 95 % confidence level. Also, the evaluation experimental data of the machine were subjected to further statistical analysis using SPSS to plot graphs that showed the interactions between the operational factors and the parameters. The graphs revealed that washing performance index (WPI) increases from 77 % to 98 % as fermentation period progresses from 2, 4 and 6 days. The melon seed washing capacity (C_S) of the melon washing machine was measured to be $51.84\ kg/h$. Again, evaluation results showed that melon samples in black and white polyethylene bags fermented faster (i.e. 2nd and 4th days) and easier to wash with the washing machine than the samples in jute bags which fermented lately (i.e. 6th days) and full of undigested melon chaff when dried. In addition, melon seeds that were fermented in jute bags appeared darker in colour after washing. Therefore, using polyethylene bags for fermentation produces better results than jute bags. Hence, the new melon processing technique for extracting and washing melon seeds from its pods is a fast and efficient technique.

***KEYWORDS**:* Washing basket, depodded melon materials, short period fermentation, bag type

1. INTRODUCTION

Melon fruit *(Citrulluslanatus)* was discovered in 17th century and a traditional processing method has been the technique used for extracting the melon seeds (Vander-vossen *et al.,* 2004). Since then, there was no verified research work done to mechanize the process until 21st century when some researchers start developing some machines to aid melon seed processing. Melon plant *(Citrulluslanatus)* was believed to have originated from the western Kalahari region of Namibia and Botswana in Africa. There are two major types of melon fruits; small fruit type with bitter pulp called *tsama-melon* and the other big type of melon fruits that is mainly used as source of water during draught period called water-melon. Also, melon is grown in India, China, Japan and other Asian countries (Vander-vossen *et al.,* 2004; Vigneault *et al.,* 1992). FAO (2002) reported that total world production of melon seeds in 2002 was 576600 tonnes produced from 608,000 ha of farmland. The production from Nigeria amount to 347000 tonnes, Cameroon produced 57000 tonnes, Sudan produced 46,000 tonnes, DR Congo produced 40000 tonnes, Central Africa Republic produced 23000 tonnes and China produced 25000 tonnes. The above statistics shows that Nigeria alone produces over 60 % of the World production of melon seeds. In addition, large amount of melon seed-oil worth billions of US Dollars were exported to Africa communities in the North America and European countries (Vander vossen *et al.,* 2004).

In most Africa countries, melon seeds are grinded and added as thickener to prepare egusi soup or grinded and fermented to produce a local sweetener called *ogiri*. In some areas, the seeds could be roasted, pounded, wrapped in leaves and then boiled to produce another sweetener called *igbalo or tasali* in Sudan and Egypt (Vander-vossen *et al.,* 2004). Also, melon plant is also grown for its oilseeds; the oil is used for cosmetic purposes and is of great interest to the pharmaceutical industries. Studies have shown that melon seed oil contains five main fatty acids; palmitic (10 %), stearic (8.33 %), oleic (13.7%), linolenic (5.3 %) and linoleic with the most abundant fatty acid valued at 64.15 %. This linoleic is used industrially as drying agent in glossy paint, detergent and soap making (Essien and Eduok, 2013). In addition, melon oilseed is classified as good energy source; for it has some fuel quality parameters that make it economical for biodiesel production (Giwa and Akanbi, 2020). The local utilization of melon oilseeds in biodiesel production in future is eminent because of its fuel properties that were observed to be close to that of the standard petrodiesel and biodiesel (Ogunwa *et al.,* 2015, Giwa *et al.,* 2013).

Despite the huge economic benefit and nutrient values of the melon seeds to Nigeria and the World at large, its processing stages from melon pod to seed are yet to be effectively mechanized. Again, processing this important seed requires fermentation process to decompose the tough epicarp, mesocarp and endocarp pulp, which lasted for 10 to 15 days or more (Akubuo and Odigboh, (1999); Orhorhoro *et al.* 2018; Shittu and Ndrika, 2012; Osunde and Vandi, 2012). Also, Jackson *et al.* (2013), Solomon and Taiwo (2020) defines fermentation as the chemical transformation of the organic substances into smaller compounds by the action of enzymes, which are produced by microorganisms such as molds, yeasts, or bacteria. There are two major types of fermentation; Aerobic and anaerobic fermentation processes and this form one of the objectives of this study; to ferment the depodded melon materials in 2, 4 or 6 days before washing the fermented melon seeds with the developed melon seed washing machine designed for short period fermented melon materials. However, Agbetoye *et al.* (2013) modified an existing melon depodding machine; the first prototype was developed by Oloko and Agbetoye (2006). Also, Nwakuba (2016) designed, fabricated and evaluated a local spike-tooth screw melon depodding machine. The design was based on the principle of impact force meant for depodding only the fermented melon pods. The existing depodding machines can efficiently depod only the fermented melon pods, but cannot handle efficiently fresh melon pods. The aim of this study was to develop a melon seed washing machine for short period fermented melon materials, to investigate short period fermentation of depodded melon materials and evaluate the performance of a melon seed washing machine.

2. MATERIAL AND METHOD

In this research work, a depodding machine was developed for fresh melon pods and the performance evaluation was successfully carried out at the Fabrication Workshop of the Department of Agricultural and Biosystems Engineering, University of Ilorin, Ilorin, Nigeria.

2.1 Design Considerations

In the proper designing and development of the melon washing machine for short period fermented melon materials, the following were put into consideration as observed by Olaoye and Aturu (2018) and Adebayo (2019).

i. Capacity of the hopper,
ii. The angle of repose of melon for the hopper design,
iii. Availability of the construction materials,
iv. Cost of the available materials,
v. The hydrodynamic properties and frictional forces inherent in melon slurry and seed,
vi. The speed of the electric motor and the impact force required to separate the melon seed from the other plant materials in the melon slurry,
vii. Magnitude of centrifugal force developed by the spinning washing disc,
viii. Thickness and length of shaft, and
ix. Stability and strength of the frames to carry other components of the machine with the view to withstand further impacted load.

2.2 Description of Melon Washing Machine

The melon seed washing machine was designed to wash the depodded melon seeds after it has been fermented for 2, 4 and 6 days. It washed off the fermented pulp from the melon seeds and ensures that the clean seeds were retained in the washing basket. The melon seed washing machine has four major components; the washing basket, washing chamber, rinsing chamber and power compartment. Figure 1 presents the pictorial view of the washing machine. Figures 2 and

3 shown the views of the melon washing machine and the components are briefly describe as follows:

Figure 1: Pictorial front view of a melon washing machine

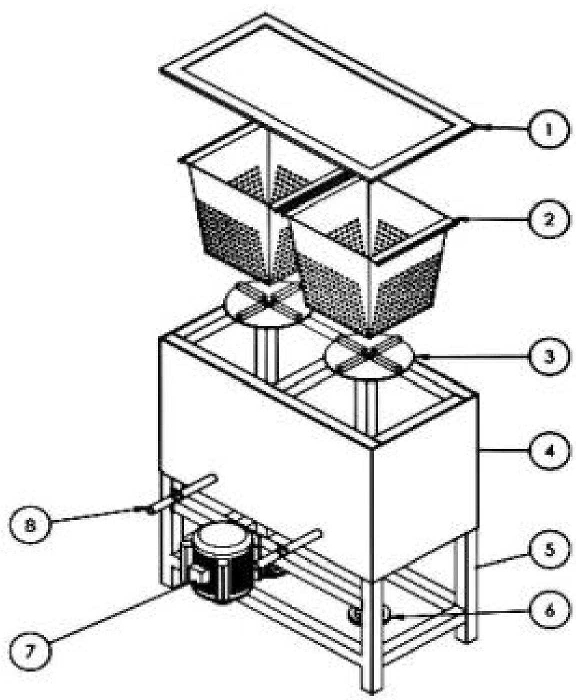
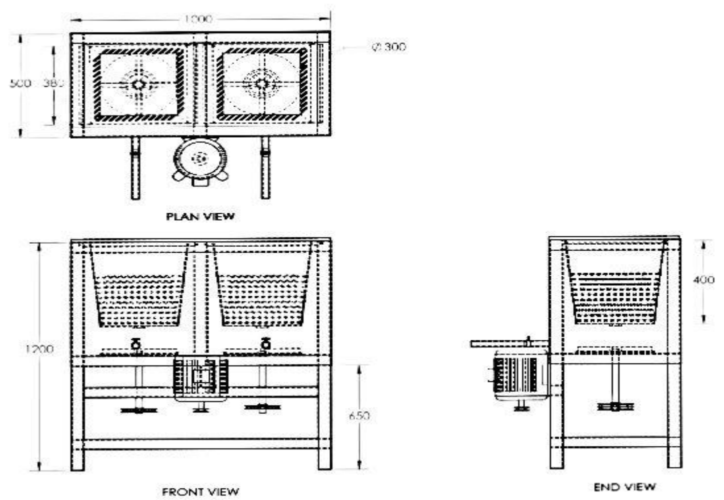


Figure 2: Exploded view of the melon washing machine

1.	Top Cover	2.	Washing Basket	3.	Impeller
4.	Body	5.	Frame	6.	Pulley
7.	Electric Motor	8.	Drain With Tap		



(All Dimension in mm)

Figure 3: Sectional Views of the Melon Seed Washing Machine

2.2.1 The washing basket

This is the component that received the short period fermented melon materials into the washing chamber of the machine. The washing basket provides the rubbing action as the spinning water moves to agitate the content of the basket which the seeds required for the separation and cleaning of the melon seeds as the washing operation progresses. After 30-60 seconds of rigorous washing with the agitated water in the washing chamber, the seed washing basket is removed manually from the washing chamber and the cleaned seeds retained in the basket are collected from the washing basket. The rotten pulp flows into the pool of water through the Ø10 mm holes drilled on the washing basket. Figures 2 and 3 showed the melon washing basket, with the dimensions of 380 mm x 450mm x 400 mm and fabricated from 3 mm mild steel plate.

2.2.2 The impeller disk

The impeller disk is the component that rotates and generates the centripetal force that creates stirring effect on the pool of water in the chambers. The agitated water creates rotary forceful action in the washing basket to separate the rotten pulp from the melon seeds. The impeller disk is fabricated from Ø300 mm disk and 4 mm thick mild steel plate with the impeller rib height of 10 mm. The impeller disk is shown in Figures 2 and 3.

2.2.3 The washing chamber

This is the first chamber where the fermented melon pulp with the seeds is washed off. The washing machine is allowed to operate for about 60 seconds, after which the rotten pulp flows out of the washing basket and the clean melon seeds are retained in the washing basket. Figures 2 and 3 showed the dimensions of the washing chamber as 380 x 500 x 550 mm^3 and fabricated from 3 mm mild steel plate.

2.2.4 The rinsing chamber

This is the second chamber where the melon seeds in the washing basket are further rinse to obtained clean melon seeds. This compartment was designed to further agitate the melon seeds in the pool of water for about 60 seconds to ensure better cleaning of the melon seeds. Figures 2 and 3 showed the dimension of the rinsing chamber as 380 x 500 x 550 mm^3 and fabricated from 3 mm mild steel plate.

2.2.5 The power compartment

This is the powerhouse of the melon seed washing machine. It housed the electric motor and other power transmitting elements like the pulley, shaft, belt, bearing and the electric motor. A 5.5 kW electric motor was used to power the impeller shafts in the two chambers. The frame members of the power compartment are fabricated from 50 mm x 50 mm angle iron. The different views of the melon seed washing machine are shown in Figures 1, 2 and 3 respectively.

2.3 Operational Principle of the Melon Seed Washing Machine

Among the required gadgets for the operation of this machine are the water pipe lines and overhead plastic water tank with capacity of 3000 litres or more. The overhead water tank is positioned at 5 metres height to enable gravity flow of water into the machine chambers. At the commencement of the melon seed washing operation, 5 kg of fermented melon materials were fed into the washing basket that is positioned in the washing chamber of the running machine. After 60 seconds of rigorous washing with the agitated water in the washing chamber, the seed washing basket with the seed was transferred to the rinsing chamber for another 60 seconds for rinsing operation with the aim of obtaining cleaned melon seeds and sun dried for 2 to 3 days.

2.4 Experimental Method for the Melon Seed Washing Machine

After the 5 kg depodded melon materials in different bags (i.e. jute, black and white polyethylene bags) have been fermented for short periods (i.e. 2, 4 and 6 days), these fermented melon materials in different bags are now ready for washing. The performance of the developed melon seed washing machine was evaluated using the fermented melon materials in bags. Some operational factors were varied to determine the effects of the factors on the performance parameters of the developed melon seed washing machine. The operational factors are four screen sizes (S) (i.e. 15, 20, 25 and 30 mm), three fermentation periods (F) (i.e. 2, 4 and 6 days) and three bag types (B) (i.e. jute, black and white polyethylene bags), with each factor replicated thrice. To evaluate the melon washing machine, the electric motor was switched-on and the washing machine was allowed to run freely for about 30 seconds, after which the fermented 5 kg of the depodded melon materials were fed into the washing machine sequentially. The washing period of 120 seconds was observed and the washing basket is drawn out of the washing machine to obtain clean melon seeds. Thereafter, the washing performance data for the runs were measured, analyzed and tabulated as shown in Table 1. The clean melon seeds were sun dried for 2 to 3 days before the melon seeds are bagged for storage.

2.5 Performance Evaluation Equations for the Machine

The equations used for evaluating the performance of the melon seed washing machine were derived and stated as follows in Equations (1) to (4).

2.5.1 The ratio of extractable seeds from the fresh melon pods ($\boldsymbol{i}$)

This is defined as the ratio of mass of extractable melon seeds to that of mass of certain quantity (i.e. 5 kg) of melon pods from which the seeds were extracted. Percentage of extractable seeds ($\boldsymbol{i}$) from certain mass (i.e. 5 kg) of melon pods was estimated using Equation (1) (Oloko and Agbetoye, 2006; Nwakuba, 2016).

$$\boldsymbol{i} = \frac{M_e}{M_p} \times 100\ \% \qquad (1)$$

Where; M_e is the mass of the seeds depodded from certain mass of fresh melon pods (kg), M_p is the mass of 5 kg of fresh melon pods fed into the machine (kg)

2.5.2 Washing performance index (WPI)

This is the ratio of the mass of the washed melon seeds to the percentage of mass of extractable melon seeds. The derived Equation (2) was used for estimating the washing performance index of the developed machine (Adebayo, 2019).

$$\text{WPI} = \frac{M_w}{M_1 \times \boldsymbol{i}} \times 100\% \qquad (2)$$

Where; M_w is the mass of seeds that was washed and retained in the washing basket (kg)
M_1 is the mass of fresh melon pods fed into the machine (kg)
($M_1 \times \boldsymbol{i}$) is the percentage of mass of extractable melon seeds (kg)

2.5.3 Percentage of seed losses ($\mathbf{S_L}$)

This is the ratio of the mass of melon seeds that escaped out of the washing basket to the percentage of mass of extractable melon seeds. The derived Equation (2) was used for estimating the percentage of melon seed losses (Adebayo, 2019).

$$(\mathbf{S_L}) = \frac{M_{sL}}{M_1 \times \boldsymbol{i}} \times 100\% \qquad (3)$$

Where; M_{sL} is the mass of seeds that escaped out of the washing basket during washing;
($M_1 \times \boldsymbol{i}$) is the percentage of mass of extractable seeds (kg)

2.5.4 Washing throughput, C_S (kg/hr)

This is the total mass of clean melon seeds over the total time taken for the washing operation. Equation (4) is used for estimating the seed washing capacity of the machine (Nwakuba, 2016).

$$C_S = \frac{M_w}{T}(\text{kg/hr}) \qquad (4)$$

Where; M_w is the mass of washed melon seeds retained in the washing basket (kg); T is the time taken for the machine to wash the depodded melon materials (kg)

3. STATISTICAL ANALYSIS

The three operational factors used in evaluation of the melon seed washing machine were screen size (S) at four levels (i.e. 15, 17, 23 and 30 mm), fermentation period (F) at three levels (i.e. 2, 4 and 6 days) and three bag type (B) at three levels (i.e. jute, black and white polyethylene bags) and the three factors were replicated thrice. The experimental design was 4 x 3 x 3 x 3 factorial design and the total experimental runs were 108 runs. The performance data were generated with their replicates and results were recorded and tabulated as shown in Table 1. The statistical analysis of variance (ANOVA) were determined and used for investigating the effects of the operational factors on the performance parameters of the of the melon seed washing machine at 95 % confidence level. Also, additional statistical results were obtained by using Duncan's New Multiple Range Tests (DNMRT) to compare the percentage mean values among different levels of the experimental factors. Table 2 showed the statistical results of (ANOVA) and Tables 3 and 5 showed the statistical results of (DNMRT).

4. RESULTS AND DISCUSSION

Tables 1 showed the evaluation results of the effects of the operational factors on the performance parameters of the melon washing machine and the effects are described as follows:

4.1 Effects of Operational Factors on the Washing Performance Index (WPI)

The statistical analysis of variance (ANOVA) results in Table 2 showed that fermentation period and its interaction with bag type have significant effects on the Washing Performance Index (WPI) at $P \leq 0.05$, while screen size and its interactions were not significant on (WPI) at $P \leq 0.05$. In addition, Duncan's New Multiple Range Tests (DNMRT) results in Tables 3 agreed with the (ANOVA) results in Table 2 that only the fermentation period and its interaction with the bag type showed some levels of significant difference at $P \leq 0.05$. Again, the (DNMRT) results in Table 5 showed that screen size has no significant effect on the (WPI) of the depodding machine at $P \leq 0.05$. Therefore, since the range of screen sizes used were of no significant value, it means difference in size reduction of the melon materials has no significant effect on the fermentation periods. However, (DNMRT) results in Table 4 showed that fermented melon seeds in the white and black polyethylene bags produced slightly higher (WPI) than the fermented seeds in jute bags.

Table 1: Effects of Operating Factors on the Melon Washing Performance Parameters (Replicated Thrice)

Experimental Runs	Washing Performance Index WPI (%)	Seed Washing Capacity C_S (kg/hr)
$S_1F_1B_1$	76.88±1.47	51.84
$S_1F_1B_2$	77.34±1.08	51.84
$S_1F_1B_3$	78.52±3.24	51.84
$S_1F_2B_1$	86.07±1.63	51.84
$S_1F_2B_2$	91.42±2.83	51.84
$S_1F_2B_3$	91.49±2.85	51.84
$S_1F_3B_1$	99.04±0.71	51.84
$S_1F_3B_2$	99.04±0.00	51.84
$S_1F_3B_3$	98.33±1.22	51.84
$S_2F_1B_1$	76.41±1.42	51.84
$S_2F_1B_2$	77.35±2.16	51.84
$S_2F_1B_3$	78.80±1.47	51.84
$S_2F_2B_1$	88.90±2.49	51.84
$S_2F_2B_2$	90.08±1.64	51.84
$S_2F_2B_3$	91.96±0.71	51.84
$S_2F_3B_1$	99.28±0.82	51.84
$S_2F_3B_2$	99.51±0.41	51.84
$S_2F_3B_3$	97.62±1.23	51.84
$S_3F_1B_1$	80.17±0.81	51.84
$S_3F_1B_2$	77.11±1.22	51.84
$S_3F_1B_3$	78.53±3.67	51.84
$S_3F_2B_1$	88.59±5.24	51.84
$S_3F_2B_2$	88.66±1.78	51.84
$S_3F_2B_3$	89.61±0.82	51.84
$S_3F_3B_1$	99.51±0.41	51.84
$S_3F_3B_2$	99.05 ±0.71	51.84
$S_3F_3B_3$	98.10 ±1.47	51.84
$S_4F_1B_1$	78.77±2.13	51.84
$S_4F_1B_2$	78.52±2.55	51.84
$S_4F_1B_3$	76.87±0.41	51.84
$S_4F_2B_1$	88.19±0.81	51.84
$S_4F_2B_2$	91.50±0.41	51.84
$S_4F_2B_3$	91.49±0.81	51.84
$S_4F_3B_1$	99.28±0.82	51.84
$S_4F_3B_2$	99.23±0.41	51.84
$S_4F_3B_3$	98.08±1.08	51.84

*S is the concave Screen Size; S_1 = 15 mm, S_2 = 17 mm, S_4 = 23 mm and S_4 = 30 mm
*F is the Fermentation Period; F_1= 2 Days, F_2= 4 Days, F_3= 6 Days
*Bag Type; B_1= Black polyethylene bag, B_2= Transparent polyethylene bag, B_3= Jute bag
*Mean of three replicates of each parameter ± standard deviation

Table 2: Analysis of Variance (ANOVA) for the Effects of Screen Size, Fermentation Period and Bag Type on the Melon Washing Performance Index (WPI)

Source	Type III Sum of Squares	Degree of freedom	Mean Square	F	Significance
Corrected Model	7989.567[a]	35	228.273	69.121	.000*
Intercept	854378.987	1	854378.987	2.587E5	.000*
Screen Size	5.776	3	1.925	.583	.628[NS]
Fermentation Period	7833.483	2	3916.742	1.186E3	.000*
Bag Type	14.978	2	7.489	2.268	.111[NS]
Screen Size * Fermentation Period	13.088	6	2.181	.660	.682[NS]
Screen Size *Bag Type	29.534	6	4.922	1.490	.194[NS]
Fermentation Period * Bag Type	64.406	4	16.102	4.876	.002*
Screen Size * Fermentation Period * Bag Type	28.302	12	2.359	.714	.733[NS]
Error	237.781	72	3.303		
Total	862606.334	108			
Corrected Total	8227.348	107			

a. R Squared = 0.971 (Adjusted R Squared = 0.957)

* Significant at $P \leq 0.05$

Table 3: DNMRT of the Effect of Fermentation Period on the WPI, ε_w (%)

Experimental Factors	Washing Performance Index (WPI) ε_w (%)
F_1	78.10[a]
F_2	89.83[b]
F_3	98.90[c]

*S is the concave Screen Size; S_1 = 15 mm, S_2 = 17 mm, S_4 = 23 mm and S_4 = 30 mm

*F is the Fermentation Period; F_1= 2 Days, F_2= 4 Days, F_3= 6 Days

*Bag Type; B_1= Black polyethylene bag, B_2= Transparent polyethylene bag, B_3= Jute bag

* Means in each column with the same letters are not significantly different at $P \leq 0.05$, but Means with different letters are significantly different at $P \leq 0.05$

Table 4: DNMRT of the Effect of Bagging Type on the WPI,ε_w (%)

Experimental Factors	Washing Performance Index (WPI)ε_w (%)
B_1	88.42^a
B_2	89.13^b
B_3	89.28^c

*S is the concave Screen Size; S_1 = 15 mm, S_2 = 17 mm, S_4 = 23 mm and S_4 = 30 mm
*F is the Fermentation Period; F_1= 2 Days, F_2= 4 Days, F_3= 6 Days
*Bag Type; B_1= Black polyethylene bag, B_2= Transparent polyethylene bag, B_3= Jute bag
* Means in each column with the same letters are not significantly different at $P \leq 0.05$,
but Means with different letters are significantly different at $P > 0.05$

Table 5: DNMRT of the Effect of Screen Size on the WPI, ε_w (%)

Experimental Factors	Washing Performance Index (WPI) ε_w (%)
S_1	88.68^a
S_2	88.81^a
S_3	88.97^a
S_4	89.30^a

*S is the concave Screen Size; S_1 = 15 mm, S_2 = 17 mm, S_4 = 23 mm and S_4 = 30 mm
*F is the Fermentation Period; F_1= 2 Days, F_2= 4 Days, F_3= 6 Days
*Bag Type; B_1= Black polyethylene bag, B_2= Transparent polyethylene bag, B_3= Jute bag
* Means in each column with the same letters are not significantly different at $P \leq 0.05$,
but Means with different letters are significantly different at $P > 0.05$

Slightly higher temperature with anaerobic fermentation that took place in the polyethylene bags was responsible for fermentation aiding properties of the polyethylene bags (Adebayo, 2019) and this agreed with the findings of Peter-Ikechukwu *et al.* (2014 and 2016) and GLBRC (2011).

Also, the evaluation experimental data of the machine were subjected to further statistical analysis using SPSS to plot graphs that showed the interactions between the operational factors and the parameters of the melon washing machine. The graphs in Figure 4 further revealed that screen size has little or no significant effects on (WPI) of the melon washing machine; for the three graphs appeared almost flat at different screen sizes. Therefore, graphs in Figure 4 showed fermentation period and bag type have significant effects on (WPI) of the washing machine; for it showed a gradual increment in (WPI) (i.e. 77 %, 91 % and 98 %) as the fermentation periods progresses from 2nd, 4th and 6th days respectively as shown in Figure 4. Again, evaluation results showed that melon samples in black and white polyethylene bags fermented faster (i.e. 2nd and 4th days) and easier to wash with the washing machine than the samples in jute bags which fermented lately (i.e. 6th days) and darker in colour as shown in Figure 5. Also, Figures 4 to 6 show samples of washed melon seeds fermented in different bags (i.e. jute, white and black polyethylene bags respectively). Evaluation results revealed there was no significant mechanical damage or seed loss recorded during washing operation, but about 1.3 % of melon seed were shelled/peeled during depodding operation with the melon depodding machine (Adebayo, 2019).

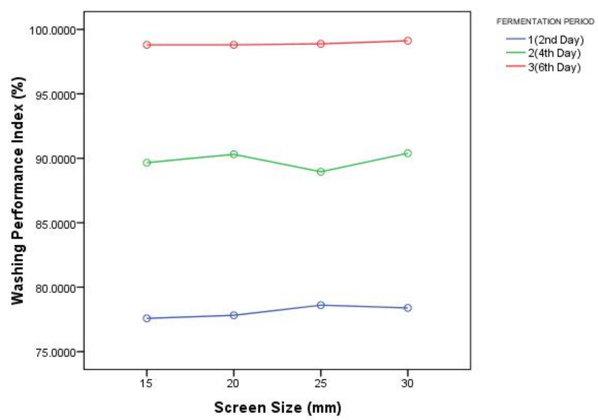


Figure 4: Effects of screen size and fermentation period on washing performance index

Figure 5: Effects of bag type on the fermented depodded melon materials

Figure 6: Samples of washed melon seeds fermented in jut bags

Figure 7: Samples of washed melon seeds in white polyethylene bags

Figure 8: Samples of washed melon seeds in black polyethylene bags

5. CONCLUSION

The performance evaluation results of the melon seed washing machine revealed that fermentation period and its interaction with bag type has significant effect on the washing performance index (WPI) of the melon seed washing machine at 95 % confidence level. However, (WPI) of the washing machine was observed to increase from 77 to 98 % as the fermentation period progresses from 2 to 6 days. In addition, the fermented melon seeds in black and white polyethylene bags were observed to produce slightly higher percentage mean values of (WPI) because the polyethylene bags produces better fermented melon seeds than the jute bags. Therefore, using polyethylene bags (whether black or white bags) for fermentation produces better results than jute bags during melon washing operation. The new melon processing technique required shorter fermentation period (i.e. 2-4 days) than other melon processing techniques because it exposes more surface areas of the depodded melon materials to microbial activities in ethylene bags, which also aids fermentation of melon seeds (Adebayo, 2019). Also, the throughput of the developed melon washing machine was evaluated to be 51.84 kg/h of melon seeds. Hence, the new melon processing technique for extracting and washing melon seeds from its pods is a fast and efficient technique.

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