EVALUATION OF DIFFERENT POLYETHYLENE COLOURS IN THE STORAGE OF "EDE-OFE" (*COLOCASIA ESCULENTA*) FOR KITCHEN CONSUMPTION

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Abstract
Laboratory study was carried out at the Department of Crop Science, University of Nigeria, Nsukka to determine the most suitable polyethylene colour for the storage of Cocoyam (*Colocasia esculenta*) "Ede-ofe". Different polyethylene colours were used to store cocoyam under room temperature to ascertain their effect on the storage ability. The experimental layout was 8x2 factorial in a completely random design (CRD) with three replications. Factor A comprised seven polyethylene colours (black, red, blue, yellow, green, purple, transparent) and the control (stored without any polyethylene cover), while factor B was two cocoyam organ types - the corms and cormels. The cocoyam were harvested, sorted, and separated into corms and cormels, cleaned and weighed differently before storage under room temperature for four months. Data were collected on the percentage weight loss, percentage rot and percentage sprout on monthly basis. Polyethylene colours and cocoyam organ types significantly ($p<0.05$) affected the weight loss and percentage rot of the cocoyam at different month interval. The corms recorded higher percentage rot, percentage weight loss and percentage sprout than the cormels. The green polyethylene gave the highest percentage rot, percentage sprout and the least weight loss whereas the uncovered cocoyam recorded the highest percentage weight loss, least percentage rot and percentage sprout. The green coloured polyethylene was adjudged the best in this study because it retained the highest weight and had the most sprouted cocoyam. Other polyethylene colours that could be used after green colour for storing cocoyam for kitchen use are red, transparent and purple.

Keywords: Cocoyam, polyethylene colours, *Ede-ofe*, rot and storage ability.

Introduction

Cocoyam (*Colocasia esculenta* L.) also known as taro (Dutta, 1990) is a member of the herbaceous monocotyledous family Aracea called Aroids. The name cocoyam is generally applied to a variety of useful and edible species belonging to different genera including *Colocasia*, *Xanthosoma*, *Alocasia*, *Cryptosperma* and *Amorphophalln*. Eze and Maduewesi (1990) noted that cocoyam is a root crop which is mainly cultivated for the edible corms although the leaves, petioles and flowers are used in soup preparation. It is about 0.5-2 meters tall and has underground round starchy corm which produces at apex a whorl of large leaves with long robust petioles. The leaves are heart shaped and the corms which vary greatly in size are surrounded by a number of corms (cormels). The root system is superficial and fibrous. The corms and cormels can be boiled, baked and consumed in different forms as soup thickeners, pounded fufu, roasted in fire as porridge and biscuit (achicha), Ugwuoke, *et al.*, 2008. It is an important source of carbohydrate for human nutrition and animal feed (Ndoumuou *et al.*, 2005; Nyochemba and Garton, 1998) and a cash income for farmers, Tombong, 1997.

Harvested cocoyam are stored in different methods to extend their shelf life for the next planting season and for subsequent use as food. A good percentage of cocoyam are ost due to the rot, weight reduction and loss of viability during storage, Ugwuoke *et al.*, 2008. In responds to this, Maduewesi (1990) recommended that harvested cocoyam should be stored in the pit or heaped on the ground the barn to reduce rot and ensure viability of corms.

In the view of the on-going, this research was done in order to determine the storage ability of cocoyam with polythene material and to determine the effect of different polythene colour on the storage ability of cocyam.

Materials and Methods

Experimental Location

The experiment was conducted in the storage room at the Department of Crop Science, Faculty of Agriculture University of Nigeria Nsukka. Nsukka is located in the derived savannah zone on the latitude 06^{o} 52North, longitude 07 24 East and altitude 447.26 m above sea level. The storage experiment lasted for four months between the early dry seasons of 24th December, 2012 and early rainy season of 24th April, 2013.

Source of Cocoyam and Storage Materials

Freshly harvested corms and cormels of cocoyam (*Colocasia esculenta var. escculenta*), *ede ofe* cultivar were collected from the experimental farm of department of Crop Science, University of Nigeria, Nsukka on 22nd December, 2012. The healthy cocoyam were separated into corms an d cormels, sorted to remove the wounded and rotten ones and cleaned to

remove the soil and the scales from the body of the cocoyam. The different polyethylene colours (black, red, blue, yellow, green, purple and white) were sourced from ogige main market, Nsukka. The corms were put into bulks in the range of 8-15 pieces and the weight of 420.0 kg – 522.0 kg in different polyethylene colours and the cormels in the range of 19.0- 36.0 pieces and the weight of 342.0kg -346.0 kg.

Storage Experiment

The experiment was laid out in an 8x2 factorial in a completely randomized design (CRD) with three replications. Factor A were the seven polyethylene colours (black, red, blue, yellow green, purple, transparent and control) and factor B were the two cocoyam storage organs, the corms and the cormels. The corms and cormels were bulked and each bulk was weighed and put at random in the different polyethylene colours. Thermometer was inserted into the polyethylene colours to take the temperature of the temperature of the storing environment for the periods of the storage. Data on the weight and the number of cocoyam rot for the both corms and cormels were taken at one month interval for four months (December to April) and sprouting potential was obtained after four months of storage.

Determination of Weight Loss

This was done using a modified method of Eze and Maduewesi (1990). The weight loss of each organ of cocoyam was determine thus:

$$\% \text{ Weight Loss} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial Weight}} \times 100$$

Deteremination of the Percentage Rot Incidence

The percentage rot incidence was determined using the method of Grllifer and Booth (1973):

$$\% \text{ Rot} = \frac{\text{Number of cocoyam rotted}}{\text{Total number of cocoyam sampled}} \times 100$$

Determination of the Percentage Sprout

This is the same with percentage rot incidence

$$\% \text{ sprout} = \frac{\text{Number of cocoyam spouted}}{\text{Total numbers of cocoyam sampled}} \times 100$$

Data Analysis

The calculated percentage data were transformed before being subjected to analysis of variance (ANOVA) according to the Procedure for CRD using GENSTAT Release 7.2 DE (Pc/Wimndows XP)

Results

The effect of polyethylene colours and organ types on the percentage rots of cocoyam after one month of storage

The result revealed that cocoyam organ types and polyethylene colours significantly ($p<0.05$) affected the percentage rot of cocoyam after one month of storage (Table 1). The corm significantly ($p<0.05$) had the higher percentage rot (31.7%) than the cormel (17.2%). The black colour of polyethylene was significantly ($p<0.05$) higher (32.7%) than all other colours except the control which had the least rot (5.4%) although the black colour was statistically ($p<0.05$) the same with blue (21.9%), yellow (25.0%) and transparent (25.9%). The interaction between the organ types and polyethylene colours showed that black polyethylene containing the corms had the highest percentage rot (55.2%) which was significantly ($p<0.05$) higher than most of the treatment combinations while control for the corm had the least percent rot (0.0%)

The effect of polyethylene colours and organ types on the percentage rot of cocoyam after two months of storage

The result showed that cocoyam organ types and polyethylene colours significantly ($p<0.05$) affected the percentage rot of cocoyam after two months of storage (Table 2). The corm significantly ($p<0.05$) had higher percentage rot of 42.1% than the cormel that had percentage rot of 20.4%. Green colour had the highest percentage rot of 41.2%, but statistically the same with all the polyethylene colours. The interaction between the organ types and polyethylene colours showed that corms stored in the green polyethylene colour gave the highest percentage rot of 60.3% and it was significantly ($p<0.05$) higher than most of the treatment combinations while the cormels used as control gave the least percentage rot of 17.9%.

The effect of polyethylene colours and organ types on the percentage rot of cocoyam after three months of storage
The result showed that cocoyam organ types and polyethylene colours significantly ($p<0.05$) affected the percentage rot of cocoyam after three months of storage (Table 3). The corm was significantly ($p<0.05$) higher (41.2%) than the cormel which had the least percentage rot of 21.9%. Green colour had the highest percentage rot of 43.8% and was significantly ($p<0.05$) different from other colours except black (36.0%), blue (33.3%) and purple (34.6%) while the control had the least percentage rot of 7.3%. Comparing the interaction between polyethylene colours and the organ types revealed that the corms stored in the green polyethylene had the highest percentage rot of 59.7% which was significantly ($p<0.05$) different from all the treatment combinations except the corms stored in black (56.0%), blue (44.8%), purple (39.4%) and red (54.4%) polyethylene and the control for cormel had the least percentage rot of 3.6%.

The effect of polyethylene colours and organ types on the percentage rot of cocoyam after four months of storage
The result revealed that cocoyam organ types and polyethylene colours significantly ($p<0.05$) affected the percentage rot of cocoyam after four months of storage (Table 4). The corm maintained to have the highest percentage rot of 44.0% which significantly ($p<0.05$) differed from the cormel that had the least percentage rot of 21.3%. Green colour had the highest percentage rot of 50.1% and significantly ($p<0.05$) differed from all the colours except the black (39.4%) and red (37.8%) while the control had the least percentage rot of 13.1%. The interaction between polyethylene colours and the organ types showed that the corms stored inside green polyethylene colour had the highest percentage rot of 66.4% which varied significantly ($p<0.05$) form other treatment combinations except corms stored in black (59.0%) and red (51.7%) while the cormels stored as control had the least percentage rot of 0.0%.

The effect of polyethylene colours and organ types on the percentage rot of cocoyam after four months of storage
The result revealed that cocoyam organ types and polyethylene colours significantly ($p<0.05$) affected the percentage rot of cocoyam after four months of storage (Table 4). The corm maintained to have the highest percentage rot of 44.0% which significantly ($p<0.05$) differed from the cormel that had the least percentage rot of 21.3%. Green colour had the highest percentage rot of 50.1% and significantly ($p<0.05$) differed from all the colours except the black (39.4%) and red (37.8%) while the control had the least percentage rot of 13.1%. The interaction between polyethylene colours and the organ types showed that the corms stored inside green polyethylene colour had the highest percentage rot of 66.4% which varied significantly ($p<0.05$) form other treatment combinations except corms stored in black (59.0%) and red (51.7%) while the cormels stored as control had the least percentage rot of 0.0%.

The effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after two months of storage
The effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after two months of storage (Table 6) showed significant ($p<0.05$) different. The corm had higher percentage weight loss of 9.5% though it was statistically ($p<0.05$) the same with the cormel (9.3%). The control had the highest percentage weight loss of 23.8% and it was significantly ($p<0.05$) different from all the colours while green had the least percentage weight loss of 2.8%. In comparing organ types and the polyethylene colours, cormels stored as control had the highest percentage weight loss of 24.0% and was significantly ($p<0.05$) different from other treatment combinations except the corms stored as control (23.6%) while the corms stored in green polyethylene had the least percentage weight loss 2.5%.

The effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after three months of storage
The polyethylene colours and cocoyam organ types had great influence on the percentage weight loss of cocoyam after three months of storage (Table 7) and they are significantly ($p<0.05$) different from one another. Corm was significantly ($p<0.05$) higher (18.5%) than the cormel (10.1%). The control recorded the highest percentage weight loss of 26.9% and significantly ($p<0.05$) differed from other colours while green polyethylene had the least percentage weight loss of 5.6%. The interaction between the organ types and polyethylene colours showed that the control for the corms had the highest percentage weight loss of 35.6% and was significantly different from all the treatment combinations while the corm stored in the green polyethylene colour had the least percentage weight loss of 5.4%.

The effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after four months of storage
Polyethylene colours and organ types of cocoyam after four months of storage (Table 8) significantly ($p<0.05$) influenced the percentage weight loss of cocoyam. The corm significantly ($p<0.05$) had the higher percentage weight loss of 11.3% than the cormel (6.9%). The control had the highest percentage weight loss of 13.6% and it was statistically the same with other polyethylene colours except green (4.0%), red (8.1%) and transparent (6.8%) polyethylene while green polyethylene had the least percentage weight loss of 4.0%. The interaction between polyethylene colours and organ types showed that the

corms stored as control had the highest percentage weight loss of 18.3% and significantly ($p<0.05$) differed from other treatment combinations except corms stored in black (15.0%), blue (14.5%), and purple (14.6%) polyethylene while the cormels stored in green polyethylene had the least percentage weight loss of 3.1%.

The effect of polyethylene colours and organ types on the percentage sprout of cocoyam after four months of storage
The polyethylene colours and organ types of cocoyam after four months of storage (Table 9) significantly ($p<0.05$) affected the percentage sprout of the cocoyam. The corm had the higher percentage sprout of 68.1% which was significantly ($p<0.05$) different from the cormel that had the least percentage sprout of 23.8%. Green colour had the highest percentage sprout of 64.9% and significantly ($p<0.05$) varied from all the colours while the control had the least percentage sprout of 23.7%. The interaction between the polyethylene colours and organ types showed that the corms stored in the green colour had the highest percentage sprout of 86.9% which varied significantly from other treatment combinations except the corms stored in black (73.8%), purple (73.8%), red (82.5%), and transparent (65.6%) while the control for the cormel had the least percentage sprout of 0.0%.

Discussion
The results of the study evidently showed that polyethylene colours and cocoyam organ types used during storage significantly ($p<0.05$) affected the percentage weight loss and percentage rot of the cocoyam at different month interval.

It was shown from the experiment that out of the two plant organs used, the corm generally recorded the highest percentage rot, percentage weight loss and percentage sprouts but after one month of storage, the cormel had the higher percentage weight loss. This result agreed with Arene (1989) who reported that after four months of storage, 94.9% of the stored corms and 36.7% of the stored cormel got rotten in the pit. Oyenuga (1968) suggested that this could be as the result of their biochemical food composition. Percentage sprout was significantly ($p<0.05$) high in the corm than in the cormel which according to Praquin and Miche (1971) could be attributed to the physiological loss associated with sprouting. Also during harvest, lots of cormels are removed from the corm and this could serve as an opening for the entrance of pathogens and a means of water loss from the corms. Though the corm had the highest percentage rot and weight loss, there was a sign of life in it than the cormel because it had the highest percentage sprout

It was also shown that out of the various polyethylene colours used, significant result was recorded on the green polyethylene which gave the highest percentage rot and percentage sprout. This is because the green polyethylene received incident radiation of short wave length (Kenneth, 1943) with increased heating predisposing the cocoyam to low oxygen, high carbon IV oxide and high relative humidity which favoured microbial growth on the cocoyam thereby increased percentage rot. Percentage sprout was also increased because of high relative humidity. Though control had short incident radiation of short wave length but due to the circulation of high oxygen and low carbon IV oxide and also low relative humidity, this hastened the rate of respiration thereby losing more weight and gave the least percentage rot and sprout.

Control gave the highest percentage weight loss. This is because of the circulation of air in the storage room. In the storage room, there was high oxygen circulation more than carbon IV oxide with low relative humidity which makes the cocoyam possible to respire faster causing high loss of weight, low percentage rot and low percentage sprout, making the cocoyam to shrink.

At the end of the study, even though the cocoyam stored in the green polyethylene had the highest percentage rot, it was preferred to the control because it retained more weight and with highest percentage sprout showing that it was still alive after the storage unlike the control which had the least percentage sprout and rot with high percentage weight loss showing that it had dried up and not good for either kitchen consumption or as planting material. Other polyethylenes that can be used after green colour are red, transparent and purple.

Conclusion
Corms and cormels of cocoyam are highly perishable. This could be attributed to their high moisture contents and chemical composition. Therefore, farmers, researchers and everybody should put in efforts to preserve the cocoyam produce to make food available for feeding increasing human population.

It was also drawn from my research work that green polyethylene colour prevented weight loss and rot in post-harvest storage of cocoyam for kitchen consumption. Also cormel stores better at one month after storage but three to four months after storage corm is preferred to the cormel. This could be adopted to minimize loss of cocoyam for kitchen consumption by all especially the housewives

Conclusively, corms and cormels stored better using green polyethylene colours in the room.

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Table 1: Effect of polyethylene colours and organ types on the percentage rot of cocoyam after one month of storage

Colour	Corm	Cormel	Colour Mean
Black	55.2	10.2	32.7
Blue	27.2	16.6	21.9
Green	51.9	11.8	31.9
Purple	26.6	25.9	26.2
Red	35.3	18.3	26.2
Yellow	26.7	20.6	25.0
Transparent	31.1	23.2	25.9
control	0.0	10,7	5.4
Mean	31.7	17.2	24.5
F-LSD (0.05) for comparing organ mean=		9.1	
F-LSD (0.05) for comparing colour mean =		18.1	
F-LSD (0.05) for comparing colour × organ mean=		25.6	

Table 2: Effect of polyethylene colours and organ types on the percentage rot of cocoyam after two months of storage

Colour	Corm	Cormel	Colour Mean
Black	55.4	14.0	34.7
Blue	36.0	15.6	25.8
Green	60.3	22.1	41.2
Purple	30.3	27.9	29.1
Red	43.6	43.6	36.0
Yellow	40.2	40.2	26.7
Transparent	37.8	37.8	30.9
Control	33.3	17.9	25.6
Organ Mean	42.1	20.4	31.3
F-LSD (0.05) for comparing organ mean=		8.8	
F-LSD (0.05) for comparing colour mean =		17.6	
F-LSD (0.05) for comparing colour × organ mean=		24.9	

Table 3: Effect of polyethylene colours and organ types on the percentage rot of cocoyam after three months of storage

Colour	Corm	Cormel	Colour Mean
Black	56.0	16.1	36.0
Blue	44.8	21.8	33.3
Green	59.7	27.8	43.8
Purple	39.4	29.8	34.6
Red	54.4	31.3	42.8
Yellow	30.9	23.1	27.5
Transparent	33.3	21.6	27.0
Control	11.1	3.6	7.3
Organ Mean	41.2	21.9	31.5
F-LSD (0.05) for comparing organ mean=		7.8	
F-LSD (0.05) for comparing colour mean =		15.7	
F-LSD (0.05) for comparing colour × organ mean=		22.2	

Table 4: Effect of polyethylene colours and organ types on the percentage rot of cocoyam after four months of storage

Colour	Corm	Cormel	Colour Mean
Black	59.0	19.7	39.4
Blue	41.5	20.4	30.9
Green	66.4	33.8	50.1
Purple	39.4	21.7	30.5
Red	51.7	24.0	37.8
Yellow	30.9	19.4	25.2
Transparent	37.2	31.2	34.2
Control	26.3	0.0	13.1
Organ Mean	44.0	21.3	32.7

F-LSD (0.05) for comparing organ mean= 7.4
F-LSD (0.05) for comparing colour mean = 14.8
F-LSD (0.05) for comparing colour × organ mean= 20.9

Table 5: Effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after one month of storage

Colour	Corm	Cormel	Colour Mean
Black	12.4	12.7	12.6
Blue	11.0	11.3	11.2
Green	5.7	9.2	7.4
Purple	8.0	9.3	8.6
Red	10.3	12.6	11.4
Yellow	17.2	12.8	15.0
Transparent	9.1	10.9	10.0
Control	8.4	20.9	14.6
Organ Mean	10.3	12.4	11.4

F-LSD $_{(0.05)}$ for comparing organ mean= 1.1
F-LSD $_{(0.05)}$ for comparing colour mean = 2.3
F-LSD $_{(0.05)}$ for comparing colour × organ mean= 3.2

Table 6: Effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after two months of storage

Colour	Corm	Cormel	Colour Mean
Black	9.1	9.9	9.5
Blue	8.9	9.5	9.2
Green	2.5	3.1	2.8
Purple	9.3	5.4	7.3
Red	8.5	9.0	8.7
Yellow	8.2	6.9	7.6
Transparent	5.9	6.7	6.3
Control	23.6	24.0	23.8
Organ Mean	9.5	9.3	9.4

F-LSD $_{(0.05)}$ for comparing organ mean= 1.8
F-LSD $_{(0.05)}$ for comparing colour mean = 3.6
F-LSD $_{(0.05)}$ for comparing colour × organ mean= 5.1

Table 7: Effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after three months of storage

Colour	Corm	Cormel	Colour Mean
Black	19.0	9.8	14.4
Blue	19.8	11.3	15.6
Green	5.4	5.9	5.6
Purple	13.5	6.7	10.1
Red	25.5	8.2	16.8
Yellow	17.8	11.2	14.5
Transparent	10.9	9.8	10.4
Control	35.6	18.2	26.9
Organ Mean	18.5	10.1	14.3

F-LSD $_{(0.05)}$ for comparing organ mean= 4.7
F-LSD $_{(0.05)}$ for comparing colour mean = 9.4
F-LSD $_{(0.05)}$ for comparing colour × organ mean= 13.3

Table 8: Effect of polyethylene colours and organ types on the percentage weight loss of cocoyam after four months of storage

Colour	Corm	Cormel	Colour Mean
Black	15.0	6.1	10.5
Blue	14.5	10.4	12.4
Green	4.9	3.1	4.0
Purple	14.6	3.5	9.1
Red	6.9	9.2	8.1
Yellow	8.4	8.5	8.4
Transparent	7.8	5.9	6.8
Control	18.3	8.8	13.6
Organ Mean	11.3	6.9	9.1

F-LSD $_{(0.05)}$ for comparing organ mean= 2.6
F-LSD $_{(0.05)}$ for comparing colour mean = 5.2
F-LSD $_{(0.05)}$ for comparing colour × organ mean= 7.4

Table 9: Effect of polyethylene colours and organ types on the percentage sprout of cocoyam after four months of storage

Colour	Corm	Cormel	Colour Mean
Black	73.8	17.3	45.5
Blue	54.8	9.8	32.3
Green	86.9	42.8	64.9
Purple	73.8	35.2	54.5
Red	82.5	31.4	57.0
Yellow	59.6	22.5	41.1
Transparent	65.6	31.2	48.4
Control	47.4	0.0	23.7
Organ Mean	68.1	23.8	45.9

F-LSD $_{(0.05)}$ for comparing organ mean= 12.4
F-LSD $_{(0.05)}$ for comparing colour mean = 6.2
F-LSD $_{(0.05)}$ for comparing colour × organ mean= 17.6