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AN ASSESSMENT OF EFFECTS OF PACKAGING MATERIALS ON THE SHELF-LIFE AND NUTRITIONAL QUALITY OF STORED CASSAVA FLOUR.

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Abstract

For a very long-time ancient people consumed what they could gather from their natural surroundings without giving a thought for storing the food. As the nomadic culture of people has gradually changed to staying in sheltered areas, the need for containers to store food has also emerged. And ever since people realised the importance to store food for their next day's consumption, food packaging and storage technology evolved in its crude form. Packaging material plays a significant role in determining the shelf life of a food product. This study assessed the effects of transparent nylon bag, transparent plastic bucket and jute sack as packaging materials on the shelf life and quality of cassava flour. The study was carried out in the Processing Laboratory of Agricultural and Bio-Environmental Engineering Department of The Oke-Ogun Polytechnic, Saki (TOPS), Oyo State. The indicators for the stored cassava flour quality for samples in the selected packaging materials are changes in weight and colouration, pest and insect infestation and growth of mould. These indicators were assessed on a two week intervals. From Two weeks after storage (2WAS) to eight weeks after storage (8WAS), there was a slight reduction in the weight of packaged and stored cassava flour in the same trend with the peak value got for cassava flour stored in transparent nylon bags and the least value for the ones stored in jute sacks. This could be due to the possibility of a relatively better aeration in the sack storage. Generally, the quality of the cassava flour in terms of colouration was not affected with the three selected packaging materials. it is recommended that packaging materials that allow a relatively better aeration should be used for storing cassava flour and some other flour from agricultural produce.

Keywords: *Packaging, storage, shelf-life, proximate analysis, cassava flour.*

Introduction

Cassava *(Manihot esculenta)*, yams *(Dioscorea spp.)*, and sweet potatoes *(Ipomoea batatas)* are important sources of food in the tropics. The cassava plant gives the third-highest yield of carbohydrates per cultivated area among crop plants, after sugarcane and sugar beets. Cassava plays a particularly important role in agriculture in developing countries, especially in sub-Saharan Africa, because it does well on poor soils and with low rainfall, and because it is a perennial crop that can be harvested as required. Its wide harvesting window allows it to act as a famine reserve and is invaluable in managing labor schedules. It offers flexibility to resource-poor farmers because it serves as either subsistence or a cash crop (Stone, 2002).

Cassava is the third-largest source of food carbohydrates in the tropics, after rice and maize (Fauquet and Fargette, 1990).Cassava is a major staple food in the developing world, providing a basic diet for over half a billion people. It is one of the most drought-tolerant crops, capable of growing on marginal soils. Nigeria is the world's largest producer of cassava, while Thailand is the largest exporter of cassava starch (FAO, 1990).

Cassava is classified as either sweet or bitter. Like other roots and tubers, both bitter and sweet varieties of cassava contain anti-nutritional factors and toxins, with the bitter varieties containing much larger amounts. It must be properly prepared before consumption, as improper preparation of cassava can leave enough residual cyanide to cause acute cyanide intoxication, goiters, and even ataxia, partial paralysis, or death (*Chiwona-Karltun et al., 2002)*. The more toxic varieties of cassava are a fall-back resource (a "food security crop") in times of famine or food insecurity in some places (Pro-MED Mail, 2017). Farmers often prefer the bitter varieties because they deter pests, animals, and thieves.

Cassava undergoes post-harvest physiological deterioration (PPD) once the tubers are separated from the main plant. The tubers, when damaged, normally respond with a healing mechanism. However, the same mechanism, which involves coumaric acids, starts about 15 minutes after damage and fails to switched off in harvested tubers. It continues until the entire tuber is oxidized and blackened within two to three days after harvest, rendering it unpalatable and useless. PPD is related to the accumulation of reactive oxygen species (ROS) initiated by cyanide release during mechanical harvesting. Cassava shelf life may be increased up to three weeks by over-expressing a cyanide insensitive alternative oxidase, which suppressed ROS by 10-fold. PPD is one of the main obstacles preventing farmers from exporting cassavas abroad and generating income. Fresh cassava can be preserved like potato, using thiabendazole or bleach as a fungicide, then wrapping in plastic, coating in wax or freezing (FAO, 2016).

While alternative methods for PPD control have been proposed, such as preventing ROS effects by use of plastic bags during storage and transport, coating the roots with wax, or freezing roots, such strategies have proved to be economically or technically impractical, leading to breeding of cassava varieties more tolerant to PPD and with improved durability after harvest. Plant breeding has resulted in different strategies for cassava tolerance to PPD. One was induced by mutagenic levels of gamma rays, which putatively silenced one of the genes involved in PPD genesis, while another was a group of high-carotene clones in which the antioxidant properties of carotenoids are postulated to protect the roots from PPD (*Morante et al., 2010)*.

Food Packaging is one of the most important processes in food industry which helps in maintaining the quality of food products during storage, transportation and distribution. It is primarily done in order to protect the food products from external influences like biological, chemical or mechanical damage; to contain the food, preserve it in its state as packed by preventing quality deterioration, and to attract consumers and provide product and nutritional information. For years, ancient people consumed fresh food which they could gather from their natural surroundings without storing the food. As the nomadic culture evolved, the need for containers to store food has also emerged. It took over 300 years for food packaging to finally evolve into the current form. There are many packaging materials used ever since. Each type of packaging material has a different role to play in packaging. Also packaging material like biodegradable packaging or edible packaging may ensure the world's need for environment friendly and natural foods which is a major global concern now-a-day. The food packaging industry has revolutionized to a great extent in the recent years with advancement of novel food packaging technologies, such as active packaging, aseptic packaging, smart packaging, bioactive packaging, edible packaging which are research trends. Advances in such packaging technology may prevent food spoilage by maintaining the food standard at the highest possible degree which may help in satisfying the needs of consumers throughout the food supply chain as well as fulfilling the requirements as per Food Packaging Laws (Sarkar and Aparna, 2020).

The objective of this study is to assess the effects of selected three packaging materials on the shelf life of stored cassava flour in terms of weight loss, change in colouration, pests and insects infestation and change in nutritional quality.

Materials and Methods

Source of Materials and Sampling Procedures

The study was carried out at the Processing Laboratory of Agricultural and Bio-Environmental Engineering Department of The Oke-Ogun Polytechnic, Saki (TOPS), Oyo State in South Western Nigeria. The cassava flour used for this experimentation was obtained from Sanngo market in Saki town of Oke-Ogun area of Oyo State, Southwestern Nigeria. Other materials used such as the packaging materials were also got from the same market. Samples of fresh white cassava flour got from the market were weighed and stored in the three different selected packaging materials. The three selected packaging materials for this study are transparent nylon bag, transparent plastic bucket with lid and jute sack. These materials were selected because they are the most encountered in households for storing cassava flour and some other food items.

Cassava Powder Quality Indicators

The selected indicators for the stored cassava flour quality for samples in the selected packaging materials are changes in weight and colouration, pest and insect infestation, growth of mould and nutritional values. These indicators were assessed on a two week intervals. The proximate analysis of the stored cassava flour was done at three weeks intervals to determine the nutritional trends of the flour at those intervals. The variations in the indicators were recorded and used in quantifying the efficacies of the packaging materials. The nutritional values were assessed further by testing for the significant difference in their values for the three treatments using One-Way ANOVA with IBM SPSS 21 as the statistical tool.

Materials Used

Materials used include:

- Cassava flour
- Bowls
- Electric weighing balance,
- Stainless trays
- Sacks
- Buckets with lids
- Transparent Nylon bags

Results and Discussions

Results of change in Physiological Weight Loss of Stored Cassava Flour

Figures 1 to 4 show the comparison between the values for the weight of packaged and stored cassava flour for a period of eight weeks. At two weeks after storage (2 WAS), the sack storage has the least difference in the weight of the stored cassava flour with an average value of 1.8g while the peak value of 4.3g was got for the flour stored in nylon bags. The trend remained the same for the stored flour at four weeks after storage (4 WAS) with difference in weight having least and peak values of 3.7g and 9.7g for sack and nylon respectively. At six weeks after storage, the trend continues with difference in weight having least and peak values of 5.4g and 12.9g for sack and nylon respectively while the difference in weight having least and peak values of 3.7g and 9.7g for sack and nylon respectively at eight weeks after storage (8 WAS) following the same manner.

Results of Proximate Analysis of Stored Cassava Flour

The results of the proximate analysis to reveal the nutritional values of the stored cassava flour before storage and the average nutritional values after storage for eight weeks were presented in Figures 5 and 6. The percentage carbohydrate content ranged from 86.83% to 88.07% for sack and nylon storage respectively. Percentage protein content ranged from 3.09% to 3.72% for Nylon and plastic respectively, percentage fat content followed the same trend with protein ranging from 1.75% to 2.17% for Nylon and plastic respectively while percentage fibre content followed the trend of carbohydrate content ranging from 0.26% to 0.31% for sack and nylon storage respectively. Percentage ash content is similar to that of moisture content and ranged from 0.95% to 1.16% for plastic storage and sack storage respectively while moisture content ranged from 5.27% to 6.85% for plastic and sack respectively. It was observed that air tight container such as nylon and plastic improve the nutritional values of the stored cassava flour than the sack.

Table 1 shows the statistical analysis of the nutritional values of the stored cassava flour in the selected three packaging materials after eight weeks intervals after storage using One-Way ANOVA.

Effects of the packaging materials on the shelf life and the quality of the stored cassava flour

The purpose of the present study was to test and to evaluate the effects of three selected packaging materials in storing cassava flour for a period of eight weeks in terms of change in physiological weight and colouration of the stored flour, growth of moulds as well as assessment of pests and insects infestation. The peak value of reduction in weight of the stored cassava flour was got for transparent nylon bag while the least value was got for the jute sack. This could be due to the possibility of a relatively better aeration in the sack storage. There was not a noticeable change in the colouration of the packaged and stored cassava flour for the period of eight weeks. There was not also growth of moulds nor pests and insects infestation on the stored cassava flour in all the three selected packaging materials. While it was observed that the peak value for reduction in weight of the stored cassava flour was got for transparent nylon bag and the least value was got for the jute sack, the air-tight containers such as nylon and plastic gave better nutritional values of the stored cassava flour than the sack.

Generally, the quality of the cassava flour in terms of colouration, growth of moulds and pests / insects infestation was not affected with the three selected packaging materials aside the slight reduction in weight of the stored flour.

Conclusions and Recommendations

The study tested and evaluated the effects of three selected packaging materials in storing cassava flour for a period of eight weeks in terms of change in weight and colouration of the stored flour cassava flour were also assessed. The quality of the cassava flour in terms of colouration, growth of moulds and pests / insects infestation was not affected with the three selected packaging materials aside the slight reduction in weight of the stored flour. There was a slight reduction in the weight of packaged and stored cassava flour in the same trend with the peak value got for cassava flour stored in transparent nylon bags and the least value for the ones stored in jute sacks. This could be due to the possibility of a relatively better aeration in the sack storage while it was observed that air-tight container such as nylon and plastic gave better the nutritional values of the stored cassava flour than the sack.

With the findings of this study, it is recommended that packaging materials that allow a relatively better aeration should be used for storing cassava flour and some other flour from agricultural produce if reduction in weight is the paramount factor but air-tight containers such as sealed plastic container for better nutritional values. It is further recommended that other flour such as yam flour or potato flour should be put through this kind of storage conditions to broaden our knowledge.

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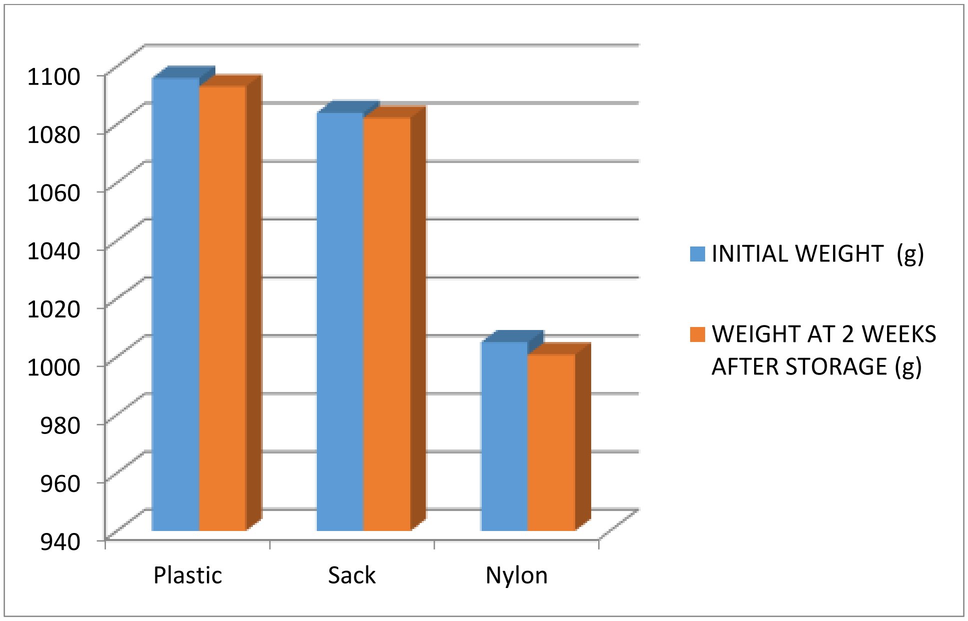

Figure 1 Comparison between the values for the weight of packaged and stored cassava flour at 2 WAS

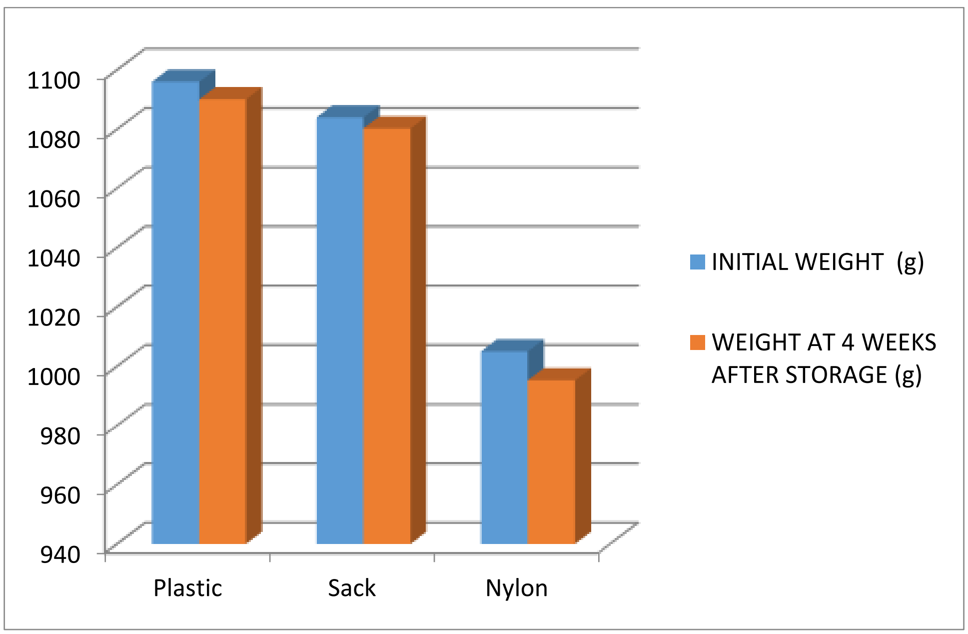

Figure 2 Comparison between the values for the weight of packaged and stored cassava flour at 4 WAS

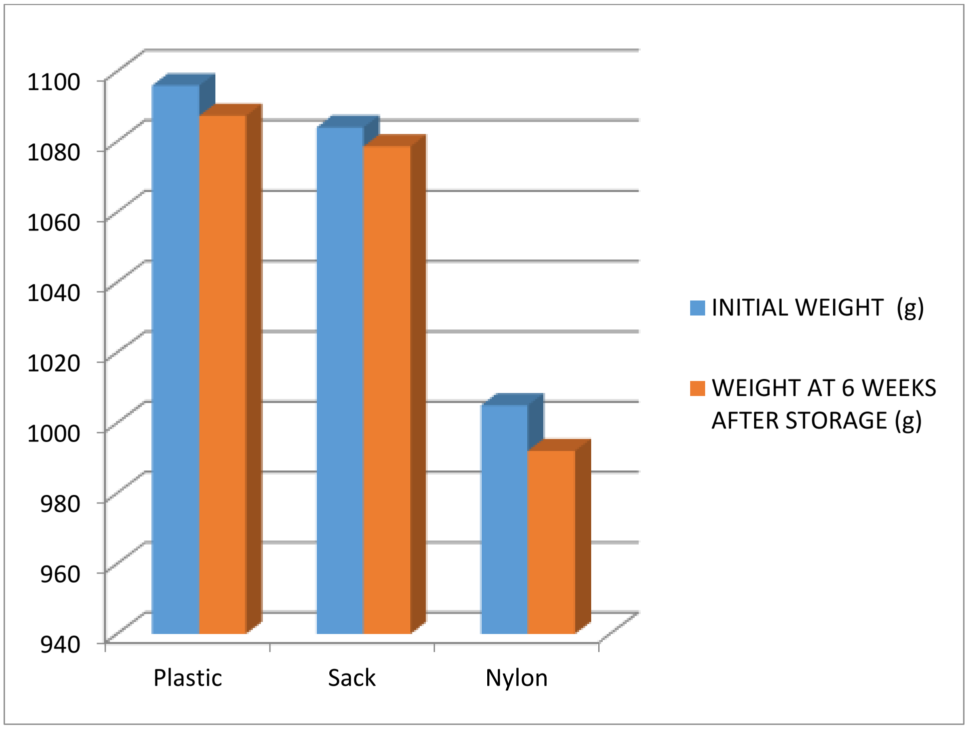

Figure 3 Comparison between the values for the weight of packaged and stored cassava flour at 6 WAS

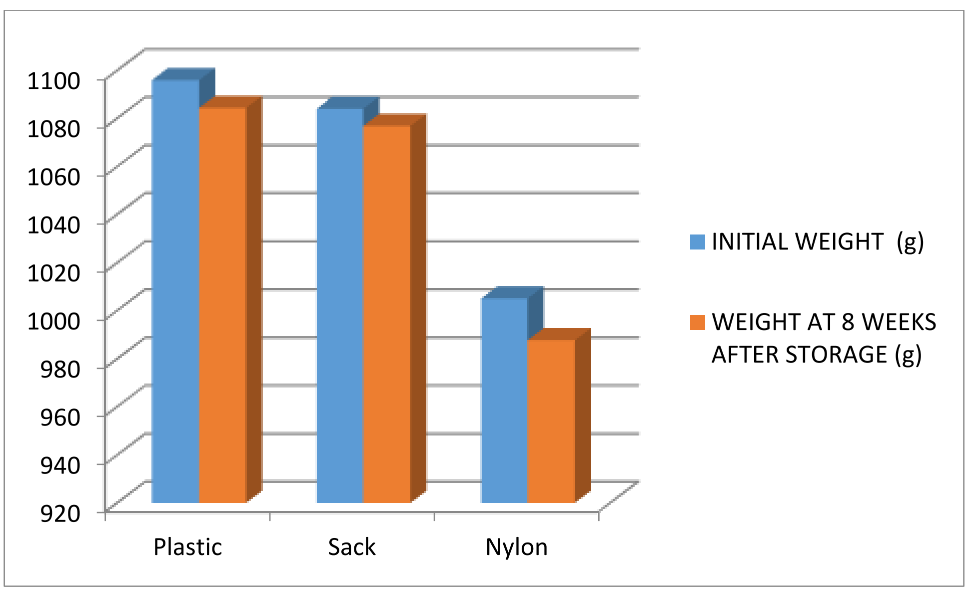

Figure 4 Comparison between the values for the weight of packaged and stored cassava flour at 8 WAS

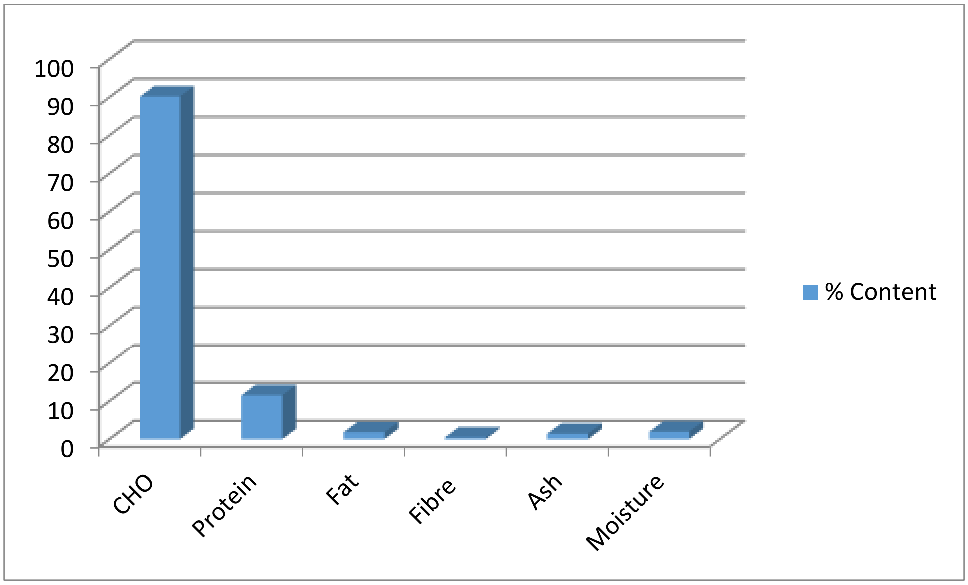

Figure 5 Nutritional values of the cassava flour before storage

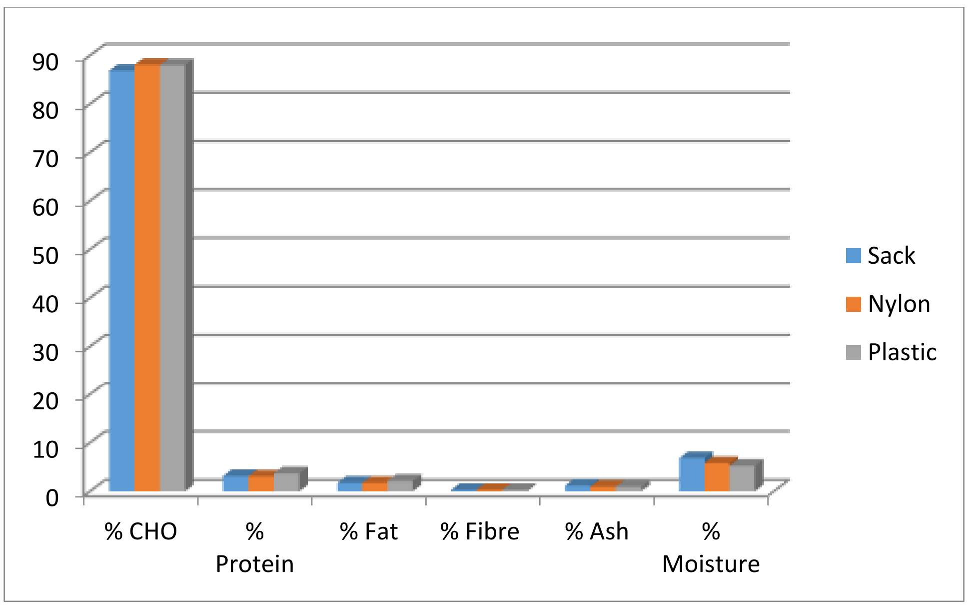

Figure 6 Average nutritional values after storage for eight weeks

Table 1 Statistical Analysis of Proximate Values at 8 WAS
ONE WAY ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
CHO	Between Groups	.883	2	.442	.341	.735
	Within Groups	3.885	3	1.295		
	Total	4.768	5			

Protein	Between Groups	2.075	2	1.038	1.521	.350
	Within Groups	2.046	3	.682		
	Total	4.121	5			
Fat	Between Groups	.183	2	.091	6.219	.086
	Within Groups	.044	3	.015		
	Total	.227	5			
Fibre	Between Groups	.019	2	.010	17.545	.022
	Within Groups	.002	3	.001		
	Total	.021	5			
Ash	Between Groups	.225	2	.112	354.526	.000
	Within Groups	.001	3	.000		
	Total	.225	5			
Moisture	Between Groups	3.212	2	1.606	19.456	.019
	Within Groups	.248	3	.083		
	Total	3.459	5			

H_o: There was no significant difference in the nutritional values for the two treatments
H_1: There was significant difference in the nutritional values for the two treatments
Since the alpha values of F (2, 3), $P > 0.05$ for both Plant heights and number of leaves, there was no significant difference for CHO, Protein and Fat for the three treatments at 8 WAS but $P < 0.05$ for Fibre, Ash and Moisture content; there is significant difference for the parameters at 8 WAS.